Compressed Air Magazine

Vol. XXXII, No. VII | London | New York | Paris | 35 Cents a Copy

JULY, 1927

CIRCULATION THIS ISSUE
31,896 *COPIES*

COMPRESSORS, HANDLING AIR OR GAS, ARE LARGELY RESPONSIBLE FOR THE WONDERFUL PRODUCTION OF THE SEMINOLE OIL FIELD

(TABLE OF CONTENTS AND ADVERTISERS' INDEX, PAGE 5)

CONTENTS OF THIS ISSUE

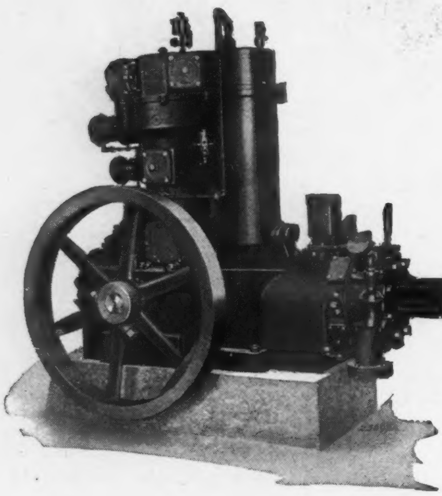
Vol. XXXII, No. 7, July, 1927

NOTE—For subscription terms see first Editorial page

Articles

Advertisements

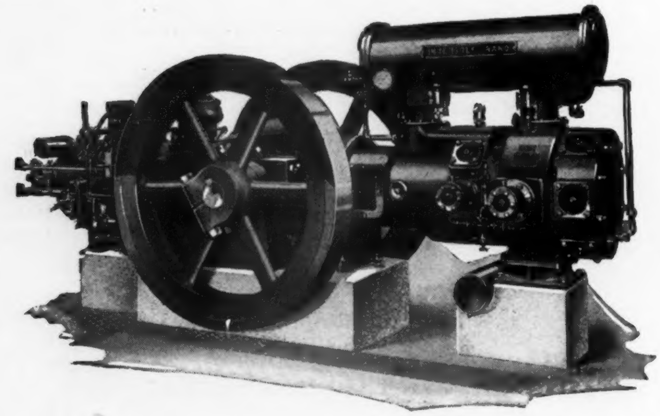
USE DIRECT-CONNECTED OIL ENGINE COMPRESSORS



THE TYPE "POV-2" AIR COMPRESSOR

(at left)

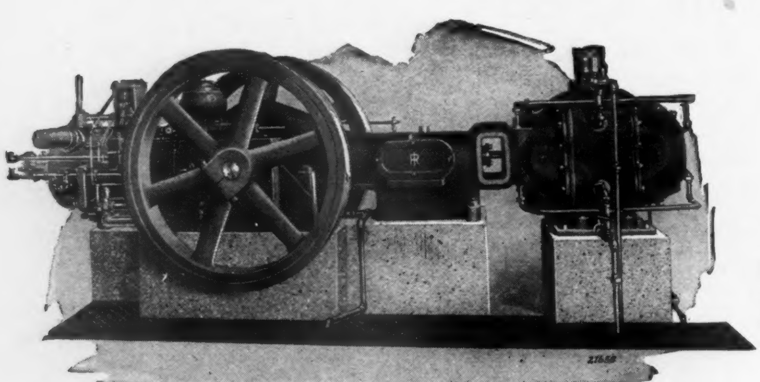
This two-stage compressor of 350 cu. ft. per minute piston displacement is designed to operate at pressures ranging from 100 to 125 pounds. It is direct-connected to the Ingersoll-Rand 55-h.p. Type "PO" Oil Engine.



THE TYPE "POC-2" AIR COMPRESSOR

(at right)

The Type "POC-2" Unit is built in sizes of 600 and 900 cu. ft. per minute piston displacement. The pressures range from 100 to 125 pounds. The two sizes of these units are driven respectively by the 110-and 150-h.p. Type "PO" Engines.



THE TYPE "POC-1" AIR COMPRESSOR

(at left)

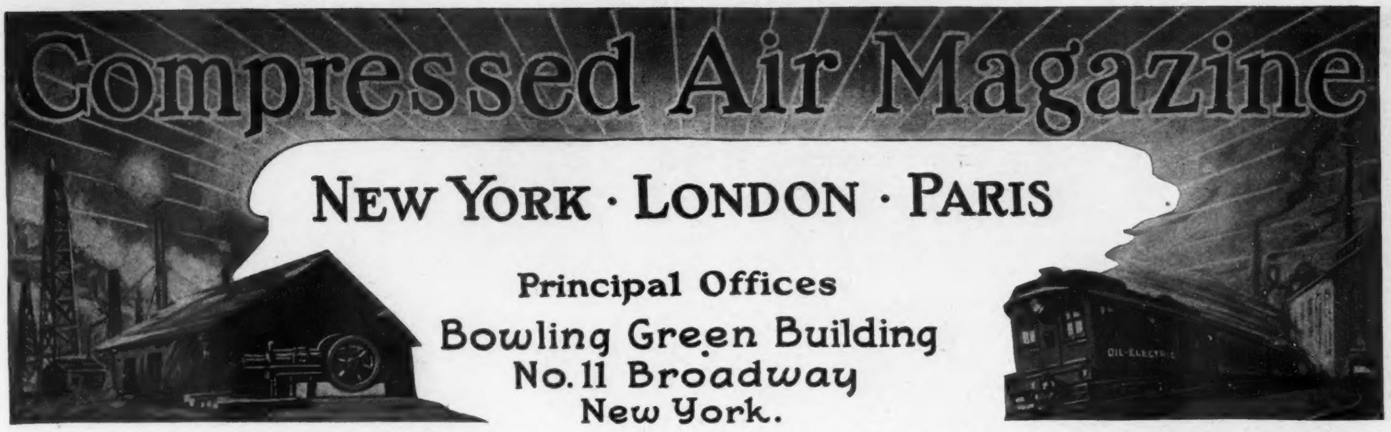
These are compressors for special capacities and pressures. They are single-stage, double-acting units direct-connected to the 55-, 110-, or 150-h.p. Type "PO" Engines.

INGERSOLL-RAND COMPANY, 11 BROADWAY, NEW YORK

Offices in Principal Cities the World Over

FOR CANADA REFER—CANADIAN INGERSOLL-RAND CO., LIMITED, 10 PHILLIPS SQUARE, MONTREAL, QUEBEC

ATLANTA
BIRMINGHAM
BOSTON
BUFFALO
BUTTE
CHICAGO
CLEVELAND
DALLAS
DETROIT
DENVER
DULUTH
EL PASO
HARTFORD
HOUGHTON
JOPLIN
KNOXVILLE
LOS ANGELES
NEWARK
NEW YORK
NEW ORLEANS
PHILADELPHIA
PITTSBURGH
POTTSVILLE
SAN FRANCISCO
SALT LAKE CITY
SCRANTON
SEATTLE
ST. LOUIS
ST. PAUL
WASHINGTON



VOL. XXXII, NO. VII

JULY, 1927

Spectacular Output of Seminole Oil Field

Big Production Largely Due to the Use of Air Compressors to Control and to Conserve Natural Rock Pressure

By ROBERT G. SKERRETT

AFTER mining petroleum by substantially unchanged methods for more than half a century, the producer has recently called to his aid new agencies that bid fair to add tremendously to the ultimate yield of our underground sources of necessary oil. That is to say, the engineer has shown how the air compressor—compressing either air or natural gas, can be utilized to conserve or to supplement rock pressure and thus induce a more prolonged or more copious flow of the oil through the sand to the well. The importance of this advance in the art is of incalculable significance, recalling as all of us can how frequently in recent years we have been warned that it was only a question of a short while before we should exhaust our pools of petroleum or, at least, reach the limit of extraction of the oil from the sands.

The accompanying article deals with what has been done lately in the Seminole district of Oklahoma in making, largely by means of the adaptation of the air compressor, record-breaking recoveries of oil that have totaled about 45,000,000 barrels in less than a year.

SEMINOLE'S surpassing performance in producing 379,981 barrels of petroleum in the course of a single day has been largely due to the employment of the air compressor as an aid both in controlling and in conserving the natural-gas pressure within the pool or field. But before telling this astonishing story of engineering accomplishment—an accomplishment that is fraught with vast economic potentialities, let us make a hasty survey of Seminole from the surface.

Less than a year ago, Seminole City was an easy-going community of 2,500 inhabitants situated in an agricultural section of Oklahoma where the local farmers devoted themselves principally to the growing of cotton and corn. Just once so often those tillers of the soil drove into Seminole to make needed purchases, to do their banking, and to talk things over with their fellow husbandmen and townspeople.

Then, almost over night, this well-ordered state of affairs was turned topsy-turvy by the work of a wildcat rig that drilled last July into the Wilcox sand and opened up a source of oil where the existence of oil had been purely speculative. Uncertainty suddenly became certainty; and a geological formation was proved to exist that gave reasonable promise of a new flood of petroleum. Lines of structural uplifts of an uncommon type were directly responsible for the astonishing revelations that followed the drilling of that first well in the Wilcox sand in the Seminole field.

Seminole City, today, is the focal point of intense activity. Where fewer than 3,000 persons dwelt and carried on their businesses in a leisurely way in the years gone, the order of life has been completely changed by the influx of substantially 18,000 strangers. Seminole has all the earmarks of a mining camp in the throes of a boom. It is raw, noisy, and pulsing with an undercurrent of lawlessness that is kept within bounds only by the courage and the diligent work of the local sheriff and his capable deputies. There is, of course, much congestion, and there are plenty of evidences of confusion; and yet, despite these hampering conditions, oil men—using the term inclusively—are carrying on and doing things that call for a goodly measure of orderliness and coördination. In short, out of this maelstrom of strenuous effort are rapidly evolving systematized arrangements capable not only of recovering a great volume of oil but also of dispatching or distributing it to points where it can be stored or can be promptly utilized by refineries.

Probably nothing is more hampering to the work in the Seminole field than the present condition of the highways or country roads over which the farmers used to move to and fro with little if any impediment. These roads are now so cut up by abnormal traffic and by the passage of heavily laden teams and motor trucks that they are alternately either seas of mud or areas deep with dust. A little rain quickly transforms the dust into miring mud, and a brief period of sunshine reconverts the mud into dust that is equally troublesome in its way; and between the ruts cut where traffic is greatest are humps that catch the unwary driver and stall his vehicle despite all the power that his engine can develop. Indeed, the situation has been so bad and the need of haste so pressing that the airplane has frequently been employed as a means of getting men rapidly to and from the field.

Transportation has been a serious problem from the beginning, and conditions have grown worse rather than better as activities have increased in the field. Horses, mules, motor trucks, and caterpillar tractors are used indiscriminately in shifting essential materials from point to point. A few figures will make the situation clear. To haul a 60-h.p. boiler a distance of only 3 miles has cost the tidy sum of $500; and concrete in place has called for an outlay of as much as $75 a cubic yard. All supplies reaching Seminole by rail are hauled by the Rock Island Railroad, which is a single-track line in that part of the State. For miles on either side of Seminole City, the sidings are crowded with long strings of freight cars

Mules and motor cars, as seen in the left and right pictures, are conspicuous in the streets of Seminole.

The center photograph gives a good idea of the rough-and-ready structures that serve as habitations in the field.

waiting either to load or to unload; and passenger trains bound east and west must zigzag in sharing the right of way with freight trains moving in the same or the opposite direction. Some idea of the volume of traffic centering upon Seminole can be had when it is recalled that in the course of a single month the revenue freight moving in and out of Seminole has exceeded that entering and leaving Chicago in the same time by the same road.

The original Seminole field extended 4 miles north, 2 miles east, and 2 miles south of the town; but the district has been expanded so as to include operations at Earlsboro, Searight, and Bowlegs. The average well is 4,200 feet deep; and the most productive of the wells have yielded as much as 9,000 barrels in the course of a day. There are at the present time about 400 wells; and recently a day's output from the district amounted to substantially 379,981 barrels—being 49,981 barrels better than the best record day made in the famous Cushing field. Possibly we can get a clearer idea of what 379,981 barrels of oil means if we realize that it would take a train about 17 miles long—made up of tank cars each carrying 8,000 gallons—to haul away this oil!

The discovery of the Seminole field was due to the enterprise of the wildcatter who was undismayed by those geologists that believed oil-bearing sands lay far too deep in that section of Oklahoma to permit of the recovery of petroleum from them. The anticlinal domes, instead of being 10,000 feet or more below the surface of the ground, have been tapped at less than half that depth, thus bringing within producing reach underground formations that may yet yield tremendous quantities of petroleum, and from whence none was thought previously to be obtainable.

As is well known, the air compressor—whether to compress air or to compress natural gas—has been used for quite a quarter of a century to stimulate the flow or output of oil wells. This adaptation of the compressor has given variable degrees of success, depending in large measure upon the cumulative knowledge acquired in dealing with different physical conditions in the several oil fields. Outstanding success latterly has opened up new and vast possibilities in the way of recovering far more oil from our underground sources than has hitherto been practicable with the commonly prevailing methods of mining petroleum. The results obtained still more recently in the Seminole field may appropriately be termed the present climax in the art of withdrawing oil from our subterranean pools. This is true not only because of the quantity of oil that has been produced through the utilization of the compressor but likewise because conditions in the Seminole field have given this application of the compressor its severest or most exacting test. To begin with, the wells are of great depth; and, next, the rock or gas pressure is relatively low, necessitating very careful handling of the compressors in order not to set up back pressures that would reduce or possibly obstruct the further natural flow of the oil through the sand to the wells.

The well that flows naturally—that is, lifts its oil to the surface, does so in most fields in the United States by reason of the impelling force of gas either lying above the oil sand and beneath the superposed rock or held in solution in the oil and becoming a propelling force when the pressure on the sand is lowered by opening a passageway to the surface of the ground—the gas then coming out of solution, like the escaping bubbles from an opened bottle of soda water, and thus pushing the oil before it or carrying the oil along with it in the form of a film or coating upon each developing and expanding gas bubble.

As long as the gas in the formation remains at a sufficiently high pressure and in sufficient quantities it will have ample power to force the oil surfaceward through the drilled well; and even later on, when this natural pressure drops, the gas

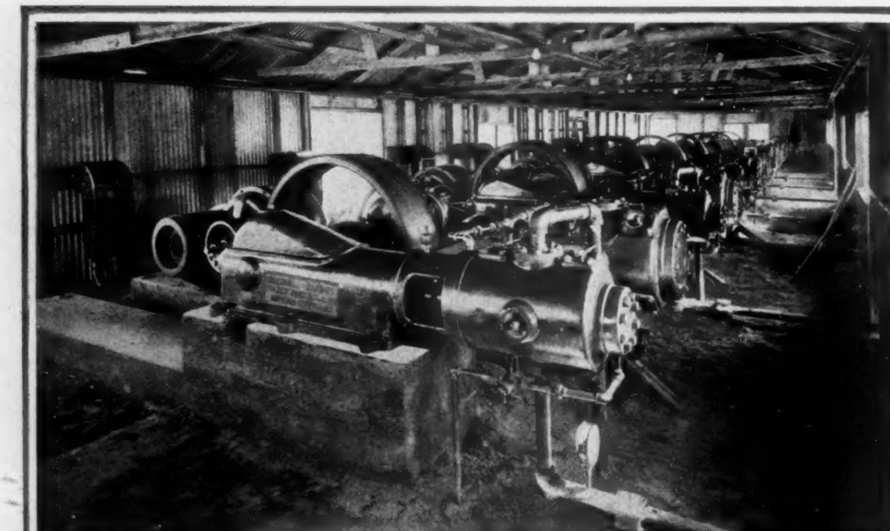
Seminole's sudden influx of population is taken care of in tents, lean-tos, camps, and a few relatively modern buildings.

1—Housing for meters that register gas used either at wells or refineries.
2—Head of a well with gas on to operate a lift.
3—An orifice meter at a well where a gas or air lift stimulates flow.
4—Intake header for a well operated by dry gas.
5—Erecting a derrick preparatory to drilling a well.
6—One of the gasoline plants in the Seminole field.
7—A well that has just been drilled in.
8—A flowing well with gas trap or separator at right of derrick.

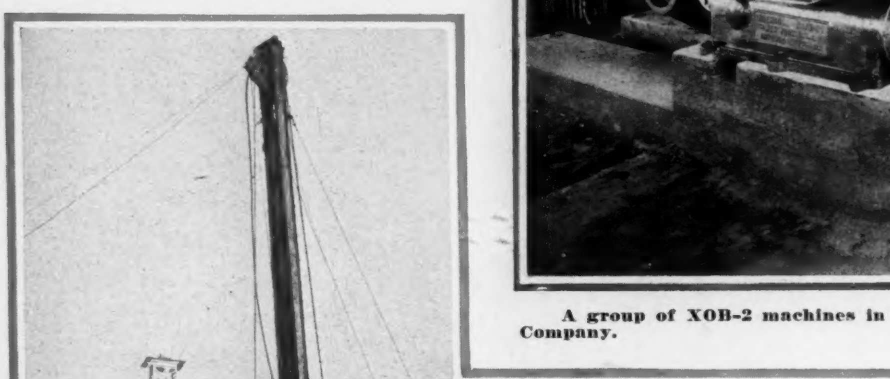
may still exert enough impulse to push the oil through the sand to the shot hole and part of the way upward in the well—the oil in the latter case being recovered by pumping or swabbing, depending on the depth of the well or the height of the surface of the oil below the surface of the ground. It should be self-evident, however, that recovery by pumping or swabbing may become prohibitively expensive if the well be very deep and if the quantity of oil that can be recovered in this way in the course of a given period be too small to warrant the outlay. Also, the growing use of the rotary drill in deep-well drilling has resulted in an increasing number of crooked holes, and this has made it more difficult to mechanically pump or swab from deep formations.

Even where the pressure of the gas in the formation is high when the sand is first tapped, still this pressure will drop rapidly within a relatively short time after the well begins to flow; and the petroleum technologist has come to realize in recent years that it behooves him, in the name of economy and efficient operation, to conserve this natural force so that it will aid him not only in the initial recovery of oil but in continuing the productivity of the formation in order that the total ultimate recovery may be correspondingly larger. Where care of this sort has been exercised, in conjunction with the employment of the air compressor to control and to conserve the natural-gas pressure, competent authorities are agreed that the ultimate yield has been and can be increased at least 50 per cent. This conclusion is of momentous significance, when it is recalled that ordinary flowing and pumping methods make it possible to recover but 10 to 25 per cent. of the oil content of a sand!

Depending upon certain physical characteristics of petroleum—these varying with different oil deposits, it has been proved by laboratory tests that a barrel of oil subjected to a pressure of 1,800 pounds to the square inch may hold in solution as much as 344 cubic feet of gas. However, oil of this particular sort, even when the rock pressure is 1,800 pounds to the square inch, may reach the surface bringing with it approximately, 2,400 cubic feet of gas per barrel of oil recovered. In other words, each barrel of oil brought to the surface with this expenditure of gas represents the dissipation of five times more gas than the barrel of oil could hold in solution; and, by escaping from the formation in this manner, there are, by inference, 5 barrels of oil left in the sand robbed of gas that might serve to move



A group of XOB-2 machines in one of the compressor plants of the Carter Oil Company.

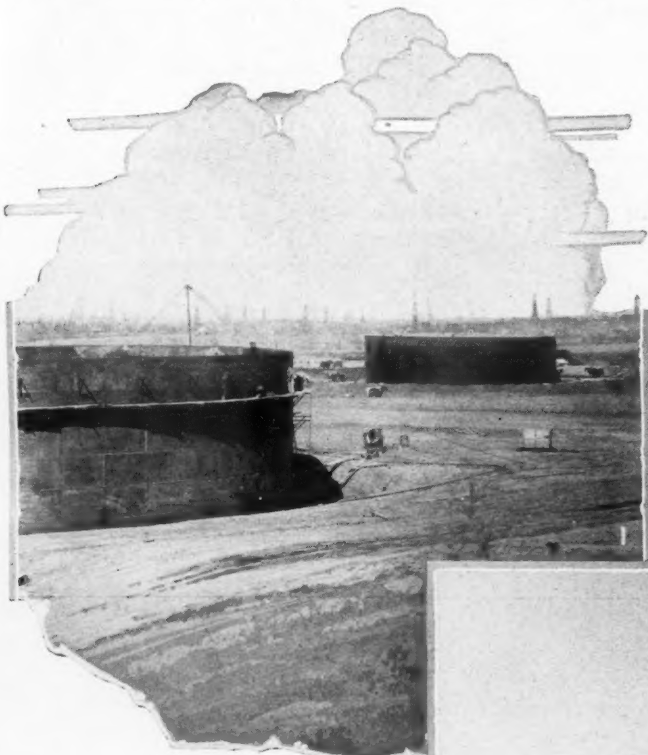


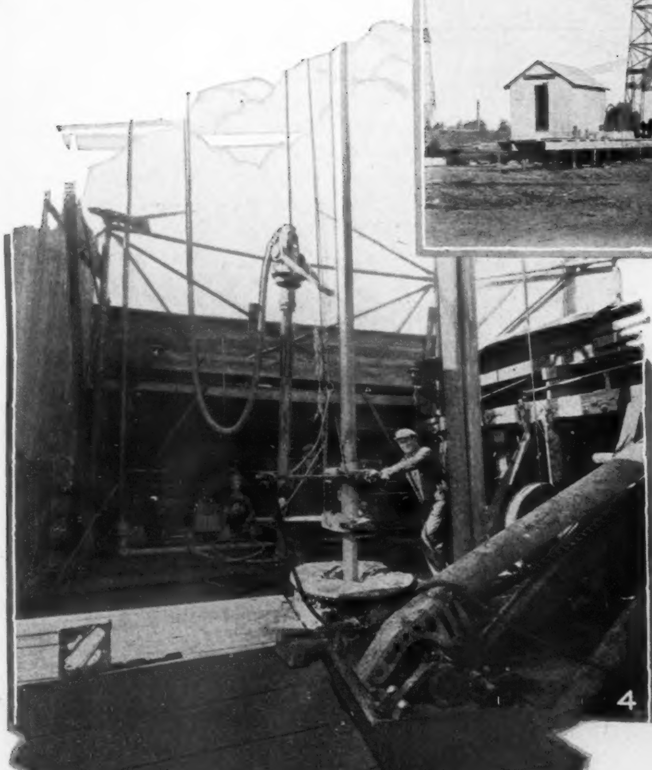
Portable drilling rig at work putting down a well in the Seminole field.

those "dead" barrels of oil to the well from whence they may be raised to the surface. Manifestly, it is important that the escape of excess gas should be checked at all times in the life of an oil well; and this precaution becomes all the more vital if the initial gas pressure in the ground is low and the formation at a considerable depth such, for instance, as prevails in the Seminole field. When the gas pressure becomes too far reduced to force the oil to decidedly deep wells, there is no way, within permissible cost limits, by which the oil can be artificially made to flow to the shot holes.

The percentage of gas brought to the surface with each barrel of oil is what is known as the gas-oil ratio. In the Seminole field, this ratio is determined with approximate accuracy by means of recording meters which make it possible to register the volume of gas delivered to the well by the compressors and the volume of gas coming from the well with the oil—the difference indicating that part of the total volume of gas contributed by the formation in helping to raise the oil to the surface.

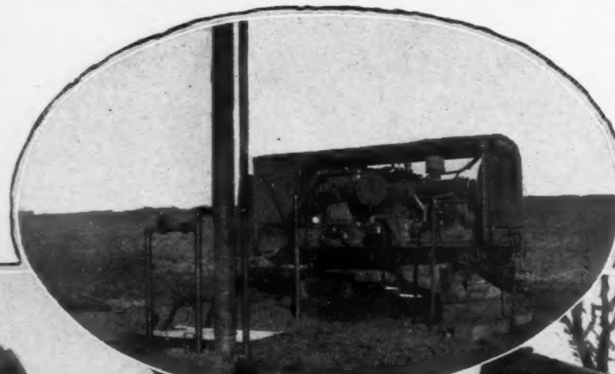
The general practice in the oil industry in the United States has been to permit an oil well to flow of its own accord as long as the gas pressure in the formation sufficed to bring the oil to the surface, and when this movement ceased, then, to begin pumping or swab-





1—Some of the 55,000-barrel tanks that are rapidly being built in the Seminole field for the storage of oil.
2—Here is seen a separator, with its hook-up, by which the wet gas is separated from the oil raised by air or gas lift.
3—Steel derricks are conspicuous features of the landscape in the Seminole oil field; and much of the drilling is done with electric power.
4—The rotary drill is extensively employed in the Seminole field down to depths of from 3,600 to 3,800 feet, after which the drilling is generally done with cable tools.
5—The ditch digger has plenty to do in excavating trenches for the pipe lines that run in all directions in the Seminole field either for delivering oil to local tanks or to more distant points.

bing in order to continue the recovery of the petroleum. This procedure has not been followed in the majority of the wells in the Seminole field. There, the compressor has been brought into play at an earlier stage so as to prolong the natural flowing period—some of the wells actually



Top—An I-R dismounted portable compressor operating a well of the Atlantic Oil Producing Company.
Left—Type of electric pump used at some wells in the Seminole field.
Right—A battery of big I-R portable compressors serving a group of wells in the Seminole field.

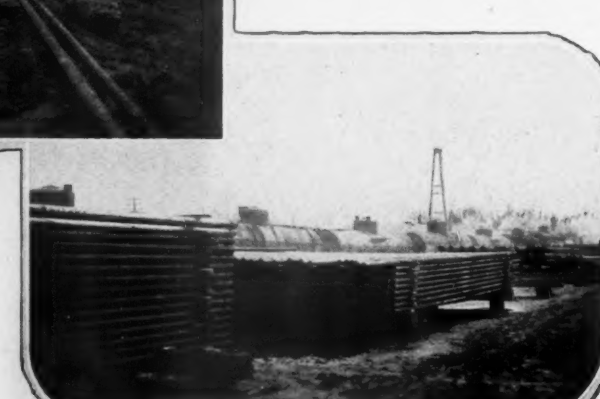
being hooked up with the compressor almost from the very beginning of their operation. The process employed is an adaptation of the air-lift principle, utilized widely and for some decades in raising water out of deep wells.

We shall not enter here into a detailed explanation of the air lift as used in pumping water other than to say that the well equipment consists fundamentally of two tubes or pipes—one within the other, with compressed air being released into one of these tubes near the bottom. The rising and expanding air produces a lighter column of combined air and water which is lifted to the surface of the ground by the greater weight of the counteracting solid column of water. One of the operative advantages of the air lift is that there are no moving mechanical parts in the well to become inefficient by reason of wear or corrosion. Manifestly, both air and water are discharged at the outlet end of the lift. Similarly, the oil reaches the top of the well; and, in certain cases, in the form of a spray.

At some wells, natural gas instead of air is compressed by the compressors and utilized to operate the lifts in the Seminole field. The reasons for using gas are: Gas is from 3 to 4 times more soluble in oil than air under identical pressure; and the gas lowers the viscosity of the oil so that it will flow more freely through the containing sand, while air tends to increase the viscosity of the oil and, therefore, may impede the flow of the oil. Furthermore, the gas is effective in absorbing gasoline in the oil—making possible a higher recovery of gasoline from the gas issuing from the gas lift. Air would lessen or dilute the gasoline content and, in the presence of water, would induce the rapid corrosion of the well casing and the smaller tubing enveloped by that casing.

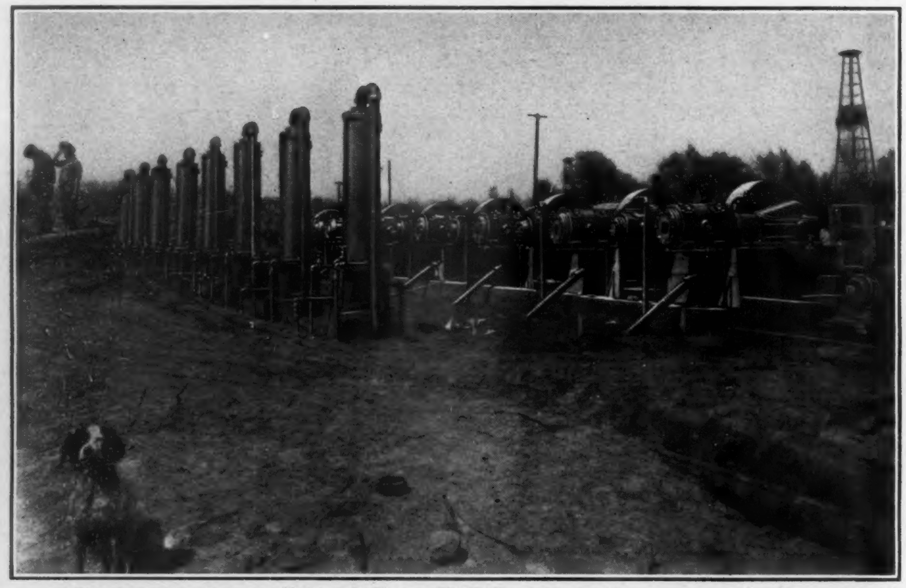
When gas is employed, the gas lift is operated as a closed cycle—the gas being used over and over, like a continuous belt, to bring the oil to the surface and to promote the recovery of gasoline. However, some companies utilize air in preference to gas because of the greater lifting power of the air and, consequently, obtain a higher production of oil upon a given volume of input of compressed air. The explanation of this is that a low percentage of the air is taken into solution by the oil and, by reason of this, more air is immediately available to help in lifting the petroleum surfaceward.

In a general way, the function of the air lift as applied to the oil well is to circulate a gaseous medium—either natural gas or air—in a well so as to raise the oil that has reached the well. The next step is to extract the gasoline from the gaseous medium that lifted the oil; then, after this treatment, the gaseous medium is recompressed; and, finally, the compressed dry gas is reintroduced into the well to continue the operating cycle. In this way, not only is the flowing period of the well prolonged considerably beyond that that would take place if only natural pres-

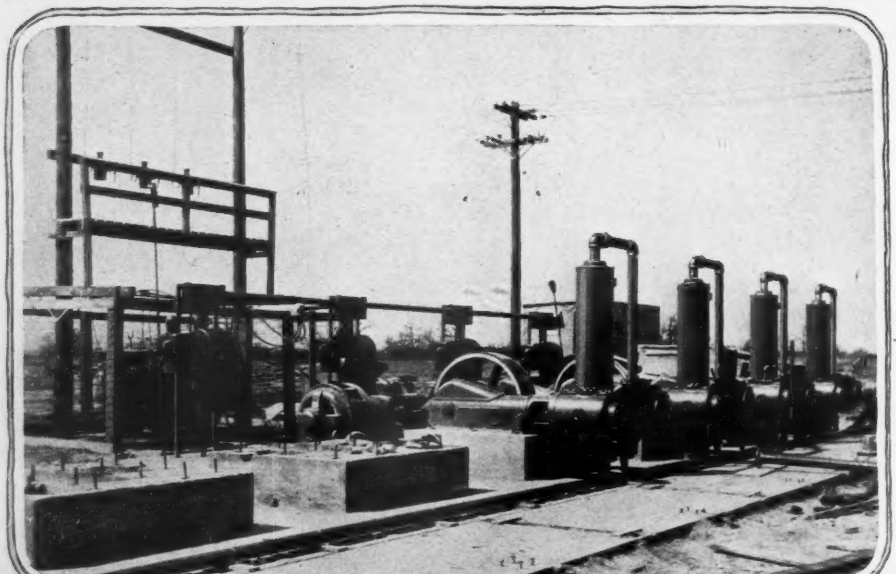


Top—Some of the numerous pipe lines that can be seen everywhere on the surface of the Seminole field.
Left—Pumping station of one of the pipe lines in the Seminole field.
Right—Innumerable piles of piping of different sizes dot the Seminole field.

1—A not infrequent traffic tie-up: mired in a highway in the Seminole field.
2—Street scene in the City of Seminole.
3—Even the caterpillar tractor is hard put to it in making headway through the streets of the City of Seminole.
4—It cost several hundred dollars to move this boiler 3 miles over roads of this kind.
5—This boiler was pulled to its destination in the Seminole field by a team of 24 mules and horses.



These eight Ingersoll-Rand Type XOB-2 compressors were actively engaged furnishing motive power for air or gas lifts long before the building was reared that now houses them.



Courtesy, Kingwood Oil & Gas Company.
A battery of XOB-2 compressors with intercoolers placed between the cylinders. These machines are at work in the Seminole field.

Courtesy, Carter Oil Company.
Interior of a compressor house, in the Seminole field, containing a battery of XOB-2 compressors mounted on timber foundations.

sure were relied upon but the introduced compressed dry gas is highly effective in increasing the total volume of recovered gasoline.

Within the limits of this article it will not be possible to enter into the various details concerning the successful and the economical use of the compressor in this extremely promising field of employment. It will have to suffice if we touch only briefly upon some of the outstanding points which must be considered in any kindred adaptation of the compressor and the air lift.

The gas-oil ratio in the Seminole field has averaged about 500 cubic feet of gas per barrel of oil, and this gas-oil ratio has indicated from the beginning that the rock pressure was decidedly low. Accordingly, low pressures produced mechanically have answered to stimulate the oil flow. On the other hand, the comparatively low rock pressure of the gas has necessitated very careful handling of the reintroduced compressed gas. For instance, on a number of occasions, the back pressure set up by lowering a string of tools in a well has either slowed up the flowing of the well or has actually stopped the flow until the tools were partly or entirely withdrawn. This merely emphasizes how needful it is, as the natural gas pressure drops, not to produce by artificial means an inhibitive back pressure that may force mud back into the surrounding sand and clog it so that oil will not move to the well. On the other hand, the gas lift, when applied to so-called "dead" wells, has been the medium of bringing about yields of from 1,500 to 6,750 barrels a day.

The "kick-off" pressure is that pressure of gas required to induce flowing to the surface through the gas lift either by way of the central tubing or by way of the annular space between this tubing and the enveloping casing. The aim is generally to keep this kick-off pressure as low as practicable so as not to apply harmful or deterrent back pressure to the oil sand. For example, one well flowing 6,750 barrels a day called for a kick-off pressure of 780 pounds, and afterwards it needed a sustained pressure of 475 pounds to maintain the flow. On the other hand, a number of wells making from 60 to 100 barrels an hour have required on an average only 260 pounds of reintroduced gas pressure—the kick-off pressure being around 500 pounds. It will be understandable, of course, that both the kick-off and the subsequent operating pressure will depend upon the height of the lift, and the gravity and the temperature of the oil. The oil from the Wilcox sand in the Seminole averages 41 degrees gravity, and the temperature is generally around 95°F.

As explained by some petroleum engineers, in order to keep the kick-off pressure as low as possible, the gas lift is often set going by "rocking" or reversing successively the movement of the oil in the tubing and in the annular space outside of it. That is to say, compressed gas is discharged into the tubing, and this is continued long enough to permit the gas to escape through the bottom of the tubing and to rise through the oil between the tubing and the casing until the oil is so lightened by this action

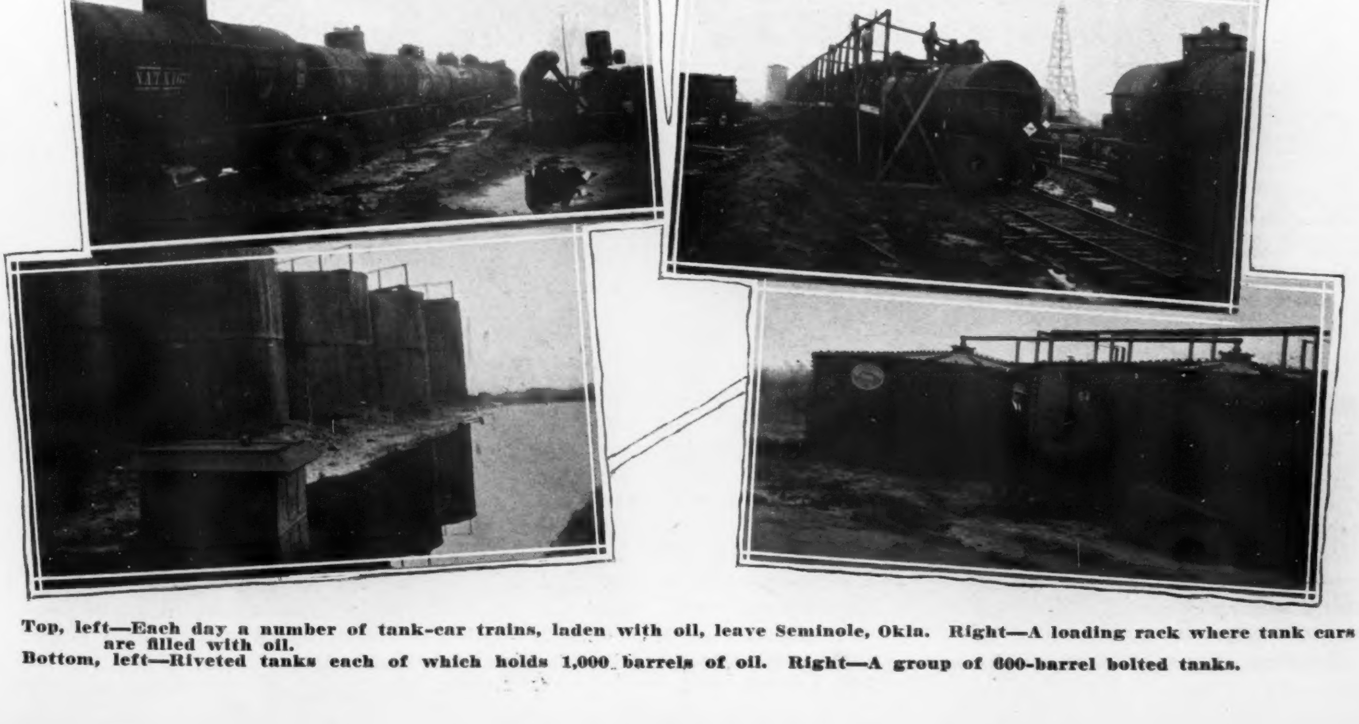
This compressor house contains eight Type XOB-2 electrically driven compressors, the property of the Carter Oil Company. The intercoolers for this plant, in the Seminole field, are placed outside the building.

that the rock pressure will cause the mixture to mount to the top of the well. Then, suddenly, gas is admitted to the annular space, and the movement is reversed so that the oil seeks an escape upward through the tubing which has become an outlet by shutting off the gas previously admitted by that passageway. As can be seen, this procedure is, in effect, a means of overcoming the inertia of the oil in the well—it is analogous to the manner in which a heavy train gains headway from a standstill by first backing a short distance and then by reversing its engine. Furthermore, this alternating movement of the two columns of oil acts like the shaking of a bottle of charged water—the gas in solution forms bubbles, and the liquid mass, so lightened, is raised to the ground surface more readily by either gas or air at a pressure lower than that required to kick off a well.

The outstanding advantage of this procedure is that a well may be started flowing by a pressure not more than 30 per cent. higher than the pressure necessary to keep the gas lift operating. Suitable connections and valves at the casinghead make possible this juggling of the readmitted compressed gas and the fluid columns. Of course, during production, a well can be flowed artificially either through the tubing or through the annular space around it—the choice depending upon conditions at each well.

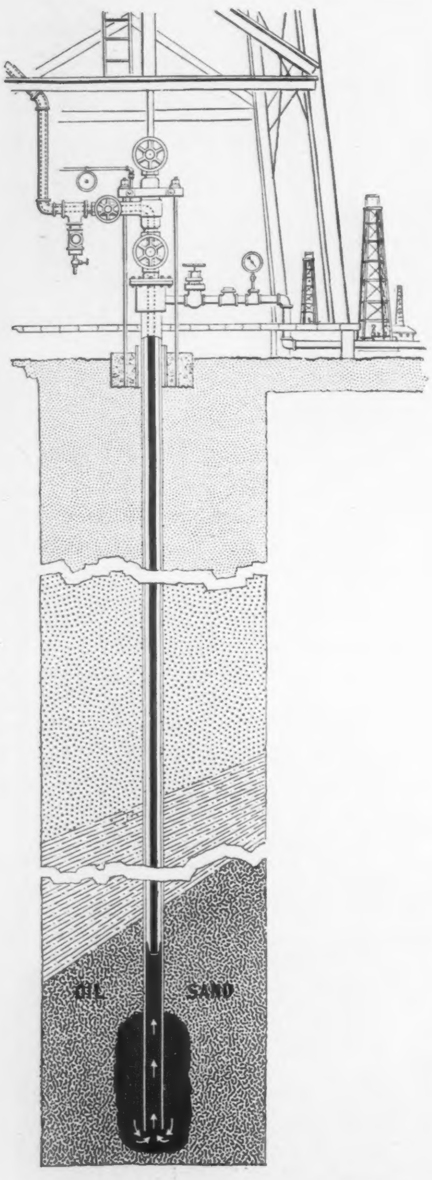
In the air lift, as ordinarily understood, the question of submergence is intimately associated with operating efficiency. In the case of the gas or air lift as a means of flowing oil wells, actual liquid submergence does not in some instances exist at the intake end of the tubing at the time the oil is being carried surfaceward through the tubing, but submergence in effect does exist because of the rock pressure that moves the oil to the well and would raise it part way up the tubing and into the annular space around the tubing if gas or air pressure were not applied from above the liquid surface. The altered liquid level is due to the fact that the introduced compressed air or compressed gas completely fills the annular space around the tubing and forces the oil level downward to the intake end of the tubing, at which point the compressed gas or air finds an easy escape surfaceward. In rushing upward, and expanding the while, the gas undergoes a big and rapid drop in pressure. As a consequence, the rock pressure, contributing the "natural-gas factor," provides sufficient additional force to raise the oil above the ground level.

The oil, on reaching the surface, is delivered



Top, left—Each day a number of tank-car trains, laden with oil, leave Seminole, Okla. Right—A loading rack where tank cars are filled with oil.
Bottom, left—Riveted tanks each of which holds 1,000 barrels of oil. Right—A group of 600-barrel bolted tanks.

to a separator or "gas trap"—the wet gas being afterwards freed of its gasoline content before undergoing recompression for return to the well. According to some authorities, the cost of raising a barrel of oil by this method will range from 5 to 30 cents, while pumping and swabbing is generally much more expensive. Indeed, swabbing, under some conditions, may entail an outlay of more than a dollar a barrel.



Essential features of an air lift or gas lift in service in an oil field. White arrows indicate movement of oil from the shot hole up in the casing and thence surfaceward through the central tubing. The white space around the oil-filled tubing shows the compressed air or gas used to lift the oil to the surface.

Each well artificially flowed by the gas lift presents its own operating problem; and, in order to ascertain as soon as possible the working pressure required, the best practice is to use for this purpose a battery of portable compressors which can be shifted from well to well during the preparatory period. Then, with the information obtained in this manner, the necessary stationary compressor plant can be installed. It is customary to continue to flow a well with portable compressors until stationary compressors can be obtained and set up. It has been found advantageous in many instances in the Seminole field to provide a number of small or moderate-sized compressors. Such a plant is economical, because any or all of these compressors can be brought into service, as occasion demands, to deal with the requirements either of one well or several wells, and with any of these wells as circumstances change. Also, this reduces the possibility of the well ceasing to flow when a single unit is down, as would be the case if but one large machine were employed.

To meet these varying conditions, compressors have been developed especially for service in oil fields in connection with gas- or air-lift pumping equipment. One very successful type of this sort is what is known as the XOB machine, which is capable of providing a starting pressure of 1,000 pounds and of maintaining a continuous working pressure of 500 pounds. This range has been found ample to meet the pressure requirements in the oil fields.

The amazing results obtained in the Seminole district, within a relatively short period of time, are evidence of the effectiveness of the gas-lift or air-lift system as a means of maintaining the flowing period of a well. But the gas lift will not be found universally applicable; and in new territory, to avoid disappointment, preliminary tests should be made with the air from portable compressors before spending money on stationary compressors. Wherever the compressor can work to advantage, it will richly repay for its employment. In conclusion, it is authoritatively said:

Most wells that can be profitably operated on the beam can be operated at much lower cost by the gas-lift method.

The reduction in gas-oil ratio, which occurs in gas-lift operations, insures a larger total ultimate recovery.

It hastens the ultimate recovery from a field by producing a greater quantity of oil in a shorter time and thus effects large savings in labor, in interest, and in other overhead charges.

It virtually obviates loss of wells through the dropping of tubing, rods, etc., because all wear and tear occurs above the ground where it may be seen.

FEWER BOULDERS IN BLASTING

An appreciable reduction in the cost of mining hard ores from stopes can be effected by the careful selection of explosives and by the use of proper blasting methods. This conclusion has been reached by the United States Bureau of Mines as the result of a series of experiments conducted in certain Arizona copper mines by the bureau working in conjunction with the mines in question.

The purpose of the tests was to determine methods of drilling and blasting that would decrease the number of large boulders in the broken-down mass. These boulders must be reduced to sizes that can be conveniently handled, and this work calls for either plugging and blasting or for breaking up the rock by hand. In addition to the expense involved, these operations constitute a hazard to miners. Flying particles of ore may cause eye injuries or cuts and bruises; and there is also the danger of drilling into missed charges.

Considering the methods of drilling and mining as fixed, the investigators sought to solve the problem by varying the established practices in regard to the use of explosives. As it costs less to break up ore by means of explosives than by hand, efforts were made to produce the desired effect with extra charges of explosives. It was found that where the walls and the back of a stope were strong enough to withstand the jar, an additional cartridge or two in a hole could often be employed to advantage. It also was learned that stemming materially helped to prevent the production of large boulders. It is recommended that at least two sticks of stemming be put in a hole as against the one stick now used in many instances.

The tests showed that a substantial reduction both in the number and in the size of the boulders can be made by employing high-grade gelatine dynamite, as this explosive possesses greater shattering power and more propulsive energy per pound. It is held that 80 per cent. gelatine powder should offer no greater risk in loading than does 35 or 50 per cent. gelatine dynamite. But the bureau does call attention to the fact that, because of the development of a relatively high percentage of carbon-monoxide gas, 80 per cent. gelatine powder should be used only in mines that are well ventilated.

The experiments proved that in a long hole, having an equal burden throughout its full length, two charges separated by stemming produce fewer boulders than a single charge. By noting the condition of the back and the face of the stope after each test round, it was established that less barring and trimming are necessary with 80 per cent. dynamite than is the case where 35 or 40 per cent. dynamite is employed.

MINING CONGRESS TO MEET IN CANADA

As an evidence of Canada's increasing international standing as a mineral producer, that country is to be host this year to the British Empire Mining & Metallurgical Congress, to open at Montreal on August 22. The Empire Mining Congress is composed of all the mining and metallurgical institutions of the British Empire and, in this case, will be accompanied by the Steel & Iron Institute of Great Britain.

The Congress will be in session six weeks, and during that time the delegates will be given an opportunity to make as thorough a survey as possible of the mineral resources of the Dominion. It is proposed to hold meetings in Quebec, Thedford, Sherbrooke, Montreal, Ottawa, Sudbury, Rouyn, Cobalt, Kirklank Lake, Timmins, Winnipeg, Saskatoon, Calgary, Edmonton, Banff, Crows Nest Pass, Cadomin, and Vancouver, with excursions into surrounding mineral fields. One novel feature will be the use of aeroplanes to carry some of the delegates from Winnipeg to the central Manitoba mining field.

Compressed Air Helps to Build a Sea Wall at the Port of Algeciras

By THE STAFF

ALGECIRAS, Spain, is on the west shore of Gibraltar Bay and directly opposite that fortified stronghold, the Rock of Gibraltar, that long dominated the entrance to the Mediterranean. Algeciras was a somewhat sleepy town that long owed its prosperity to visiting invalids, drawn there by the fine winter climate for which the place is noted. Algeciras might have continued its slumberous existence had it not become the cause of international comment, if not concern, owing to the conference held there early in 1906 to discuss the momentous question of Moroccan affairs—a conference that resulted in a significant agreement between France and Germany.

Diver ready to descend with grouting nozzle for the purpose of filling openings in the sea wall with a binder of concrete.

Historically, Algeciras has a record which shows her to have been prominent in the centuries gone. There is reason to believe that Algeciras was the *Portus Albus* of the ancient Romans; but, whether or not this was the case, there is every likelihood that the place was refounded by the Moors at the beginning of the eighth century and retained by them until 1344, when that Moorish stronghold was captured by Alfonso XI of Castile after a siege lasting for 20 months, in which crusaders from all parts of Europe shared.

According to tradition, the Moors used gunpowder for the first time in Europe during that siege. After the destruction of the city by Alfonso, the place was virtually deserted until Spanish colonists established themselves there in 1704. When Gibraltar was besieged from 1780 to 1782, the Spanish fleet was based upon Algeciras; and it was off Algeciras that the British fleet, under Admiral Sir James Saumarez, decisively defeated the combined French and Spanish fleets on July 12, 1801, after the British ships had been repelled and badly damaged six days previously. So much for the memorable past of the port.

Because of its exposed position, the Harbor of Algeciras long offered but little protection to shipping when certain tempestuous winds swept the Mediterranean. Even so, it became an important rendezvous for fishing craft early in the present century. In order to foster this industry and to make the Port of Algeciras of still wider usefulness, the Spanish authorities undertook the construction of a masonry breakwater that would serve to form an artificial haven against stormy seas; and it is with this work that the present article has to do.

The sea wall is built of large blocks of cut stone that are so set that they form two parallel walls between which boulders and smaller rock are dumped and afterwards solidified by grouting. The external masonry blocks also are bound with grouting forced into the seams by compressed air. The grouting is delivered pneumatically, by hose, to the space containing the boulders and rubble.

To facilitate the building of the sea wall, the port authorities called into being a floating plant consisting fundamentally of a barge carrying a Type Twenty portable air compressor delivering air to two 3x8-foot auxiliary receivers. Upon the barge was placed, besides, a cement injector operated with compressed air. The compressed air made available for grouting likewise serves to furnish air to the divers engaged in filling the underwater seams of the sea wall. The auxiliary receivers insure an ample supply of compressed air at a suitable pressure for the various grouting operations even when the compressor is momentarily inactive.

The method resorted to in cementing the masonry seams has been as follows: After a course of blocks has been laid and leveled, the joints are calked or packed at their outer openings with sacking—leaving holes at intervals into which the discharge nozzle can be inserted for the injection of the cement. The purpose of the packing is to direct the flow of the penetrating cement.

At times, the blocks of stone have met so snugly that a sufficient opening was not left for inserting the grouting nozzle, and, therefore, holes had to be drilled for this purpose. This work has been done with an air-driven "Jackhamer" operating underwater—a rather novel expedient being resorted to to keep the water from flooding the rock drill. That is to say, the starting throttle, instead of being attached at the inlet connection, is fitted to the discharge port of the drill which can, therefore, be kept continually under air pressure when submerged. To start the drill, the diver has only to open the valve so as to allow the air to escape by way of the exhaust port. The "Jackhamer" used successfully in this work is of the well-known BCR-430 type.

Here the floating equipment is delivering fluid concrete under air pressure to the intermediate space between the two outer parallel courses of masonry forming the sea wall.

Paving Breakers Clean Glass Furnace In Record Time

By J. H. WILKINS

PAVING breakers recently found a new field of use in removing a solid mass of glass from a furnace in the Tygard Valley Glass Company's plant at Washington, Pa. Supplanting hand methods of demolition, these air-driven tools saved both time and money in such a convincing manner that they will be exclusively employed there hereafter for work of a similar nature. Comparative data reveal that the pneumatic method costs but 32.7 per cent. as much as handwork, that it entails only 18 per cent. as much man power, and that it effects a 58 per cent. saving in time consumed.

In the glassmaking industry it becomes necessary on occasions to clean out the bottoms of the furnaces. The Tygart Valley Glass Company, in common with other concerns, has in the past accomplished this with a crew of men using sledges, moils, chisels, and pinch bars. This is a laborious, tedious, and costly procedure; and for that reason C. E. Stewart, manager of the Tygart Company, determined to experiment with paving breakers.

The furnace on which the test was made measures 21½x100 feet. In the bottom of this furnace was a 5-foot mass of unbroken glass—an immense slab containing 398 cubic yards. A paving breaker, weighing 50 pounds, was first tried, but it proved too light for the work. It was replaced by 80-pound CC-35 paving breakers. This type of machine turned out to be entirely satisfactory.

Moil-pointed steels of both 14- and 18-inch lengths were used. The 18-inch steels were found to be best for the purpose, as they could be driven deeper into the glass. The experiments disclosed that by employing a point slightly blunter than the standard moil point the steels did not have to be sharpened as frequently as would otherwise have been the case. The blacksmith also tried various tempering heats in reconditioning the steels. He learned that the best results were secured by bringing the point to a straw-yellow color for a distance of half an inch back from the tip, with the remainder of the point showing a blue color.

The equipment used consisted of two CC-35 paving breakers, two 50-foot lengths of ¾-inch air hose, and 8 steels. Air at 90 pounds pressure was supplied; and a crew of 12 men was employed. Each paving-breaker operator had a helper who used a pinch bar to pry pieces of glass from the mass as they were broken loose. Four men passed the shattered glass out of the furnace and four others wheeled it from the building. Working in 8-hour shifts, the men accomplished the task in 15 days. One paving breaker was operated 35 hours and the other 34 hours—a total of 69 breaker-hours on the entire job.

The following cost figures of the work when done by hand and by machine should prove of interest; and, as a basis of comparison, the company used records available on the hand breaking of 267 cubic yards of glass in its own plant. Despite the fact that that mass was smaller, its removal required the services of 18 men over a period of thirty-six 8-hour days.

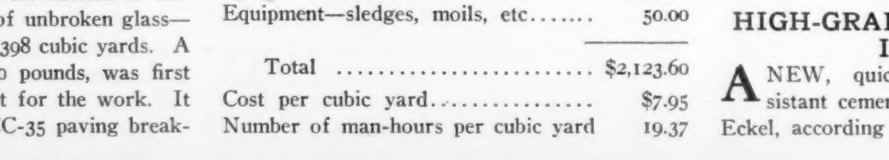
Hand Method

Labor—18 men working 36 days of 8 hours each, @ 40c an hour	$2,073.60
Equipment—sledges, moils, etc.	50.00
Total	$2,123.60
Cost per cubic yard	$7.95
Number of man-hours per cubic yard	19.37

Paving-Breaker Method

Labor—12 men working 15 days of 8 hours each, @ 40c an hour	$576.00
Equipment—paving breakers, air hose, and steels	449.00
Lubricating oil	1.50
Compressed air @ 5c per 1,000 cubic feet	11.17
Total	$1,037.67
Cost per cubic yard	$2.60
Number of man-hours per cubic yard	3.61

An analysis of the foregoing tabulations brings out the following points: First, that the paving-breaker method saved $5.35 on every cubic yard of glass removed; second, that it saved 15.75 man-hours per cubic yard of glass; third, that the saving on 86 cubic yards of glass paid for the equipment, power, etc.; and fourth, that the total saving effected in disposing of the 398 cubic yards of glass with compressed air was $2,129.30. As no tool breakage occurred, the conclusion is warranted that the equipment employed is admirably suited for the purpose.



Paving breakers proved extremely effective in breaking up a solid mass of glass that had to be removed from this furnace undergoing repair.

HIGH-GRADE CEMENT FROM ILMENITE

A NEW, quick-hardening, chemically resistant cement has been invented by E. C. Eckel, according to the *Engineer*. "Titan cement," as it is called, is made by smelting in a blast furnace titaniferous iron ore with enough lime and aluminous material to form a titanium-calcium - aluminum - iron slag, which consists essentially of calcium titanate with subordinate quantities of ferrites, aluminates, and calcium silicate, and contains 2 to 10 per cent. of iron oxide. The remainder of the iron is reduced to metal and drawn out below, as in ordinary smelting. It is claimed that if the lime is kept below 50 per cent., preferably around 30 to 40 per cent., the cement or finely ground slag hardens rapidly after a normal set and attains high strength in from 24 to 48 hours.

Harnessing the Gatineau River

International Paper Company Has in Hand a Vast Program of Industrial Development on This Waterway

PART I

By R. C. ROWE

WE live in an age of huge undertakings and imaginative ventures. In this category very properly belong the operations of the International Paper Company which have attained such proportions that they transcend considerations like boundaries and nationalities, and which contain enough romance to satisfy the most exacting because their object is to convert, upon an enormous scale, latent and inactive resources into national assets.

The International Paper Company is the world's largest manufacturer of paper, and one of the largest producers of hydro-electric energy. Together with its subsidiaries, the company owns over 12,000,000 acres of timberland; and its power developments will aggregate around 600,000 h.p., of which 500,000 will be hydro-electric and 100,000 hydraulic. Its undeveloped power sites are capable of an additional output of around 800,000 h.p. The present power projects include the installation of three power plants on the Gatineau River, the enlargement of the existing Kipawa plant, and the development of Grand Falls, New Brunswick.

The company owns and operates a 600-ton newsprint mill at Three Rivers, Quebec, and is constructing another 600-ton paper plant at Gatineau, near Ottawa. It has sulphite plants at Hawkesbury, Quebec, and at Kipawa; and its output of sulphite pulp is around 385 tons a day. Thus it will be seen that the company's scheme of expansion and development in Canada is far flung.

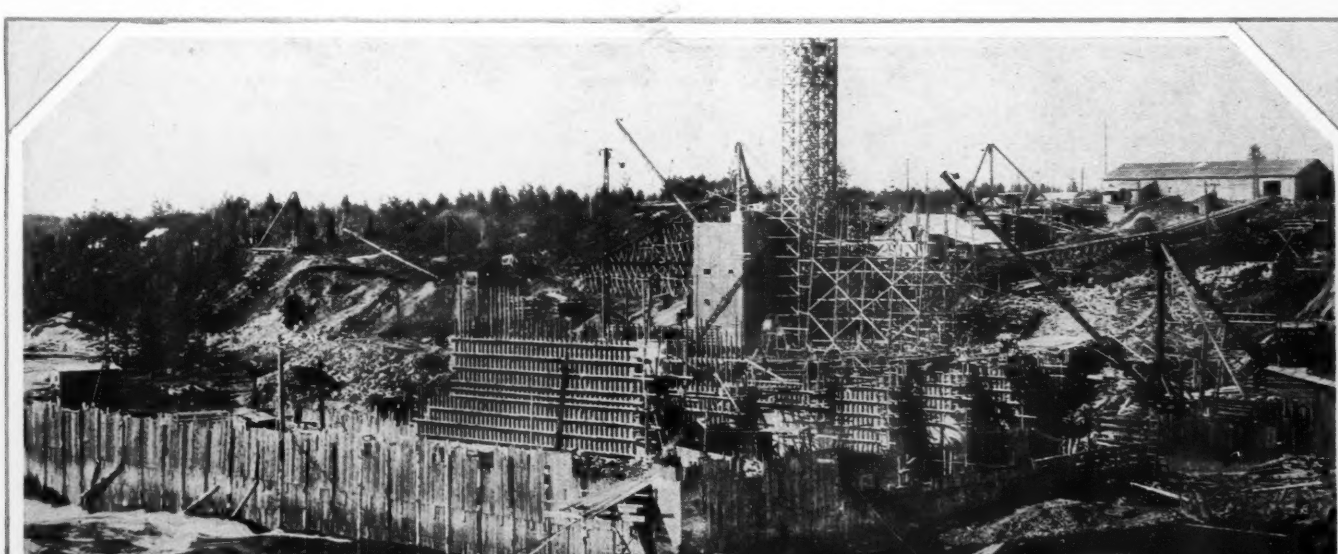
FOR ages, the waters of the Gatineau River followed their picturesque and at times tumultuous course southward to the Ottawa on their ceaseless journey to the sea, dissipating an enormous volume of energy the while. Man has only lately undertaken to put this energy to commensurate service.

Now, thanks to the enterprise of the International Paper Company, the Gatineau is being harnessed at three strategic points to drive waterwheels which will transform the river's current into a tide of electric current of more than 400,000 horsepower. Much of this electricity will be used at a great plant, also on the Gatineau, capable of producing 600 tons of paper a day! The three power plants will involve an outlay, so it is said, of substantially $50,000,000.

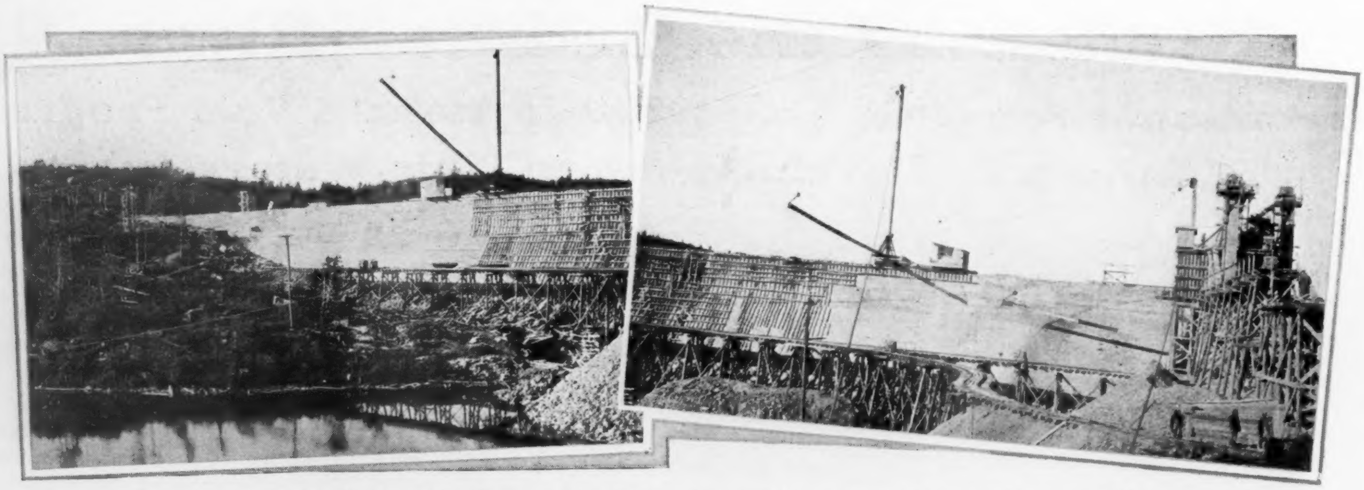
Four miles or so east of the City of Ottawa, and at the junction of the Gatineau and Ottawa rivers, lies the Village of Gatineau Point. Years ago this small French-Canadian village was a place of note. Here lumbermen and river drivers from the Gatineau used to gather in the spring. But as the big pines disappeared, and as the picturesque lumberjacks of a generation gone became scarcer, Gatineau Point settled down to a somnolent existence.

The Gatineau River, famous in lumbering annals, winds its way for about 240 miles through the rounded Laurentian Hills. As the scenic beauty of the Gatineau country was noised abroad, that region soon added to its fame by becoming a recognized summer resort. Pleasant as all this was, still the Gatineau River slumbered in a sense, and its waters—with their latent power—thundered on unheeded.

This state of affairs continued until about two and a half years ago. Then men, in service-worn khaki, began to arrive with instruments. They did many and apparently disconnected things. They drove multitudes of pegs in the ground; and held their peace. They appeared at various places along the river near



Early stage in the construction of the Bitobee Dam, showing section on the west bank of the Gatineau River.



As the Castor Lake Dam appeared from two points of view when nearing completion.

the Village of Gatineau Point, and far, far up in the bush close to the headwaters of the stream. Subsequently, their places were filled by other men, who built up small towns or camps. Next, came an army of workmen; and, simultaneously, the development policy of the International Paper Company became public property.

In its entirety, the program laid out is of great magnitude. Roughly, it may be divided into two sections: the erection of a 600-ton paper works at a point on the Ottawa River about midway between the villages of East Templeton and Gatineau Point, and the harnessing of the Gatineau River by three hydroelectric plants with a capacity of more than 400,000-h.p.

The acquisition of millions of acres of potential pulpwood around the headwaters and the tributary streams of the Gatineau has rendered all this possible. The logs cut on the company's lands will be floated down the river to the pulp and paper mills at Gatineau. These mills will be driven by electricity generated at superpower plants under the company's control. Thus we have a perfectly balanced commercial structure, backed by the business and executive ability of men of long standing in the industry. Outstanding among these is A. R. Graustein, President of the International Paper Company and head of the world's greatest paper-manufacturing organization.

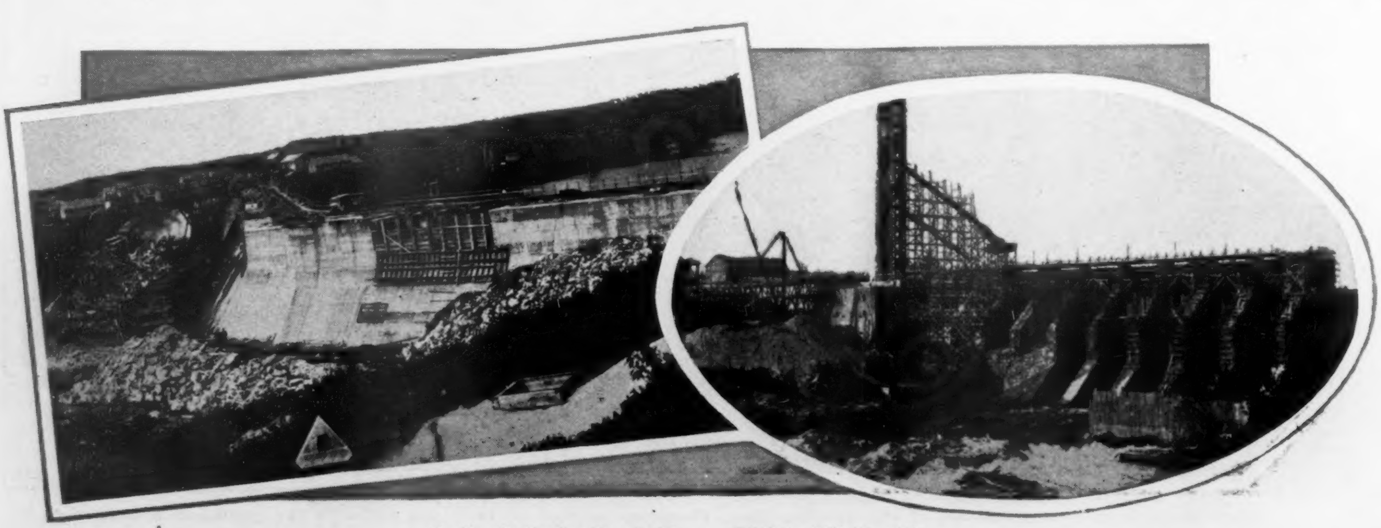
The two projects on the Gatineau are handled by separate subsidiaries owned by the parent company. The pulp and paper works are in the hands of the Canadian International Paper Company, with Mr. Graustein as president and Brig. Gen. J. B. White as vice-president. The power development is under the supervision of the Gatineau Power Company, with a directorship similar to that of the foregoing organization and with G. Gordon Gale as general manager. This company has contracted to supply for a period of 30 years anywhere from 230,000 to 260,000 h.p. of electrical energy to The Hydro-electric Commission of Ontario, a fact that places the Gatineau Power Company in a fundamentally sound position. Work is proceeding at five points; and about 8,000 men are employed.

In describing the details of this extensive program we naturally turn first to the hydroelectric developments; but, before doing so, it might be well to say something about the Gatineau River— the largest tributary of the Ottawa. Like all rivers rising in the north, it is seasonal in flow and subject to great fluctuations in level. Thus, during periods of spring freshets it attains flood proportions, while in the summer months it dwindles to a flow of around 2,500 cubic feet per second.

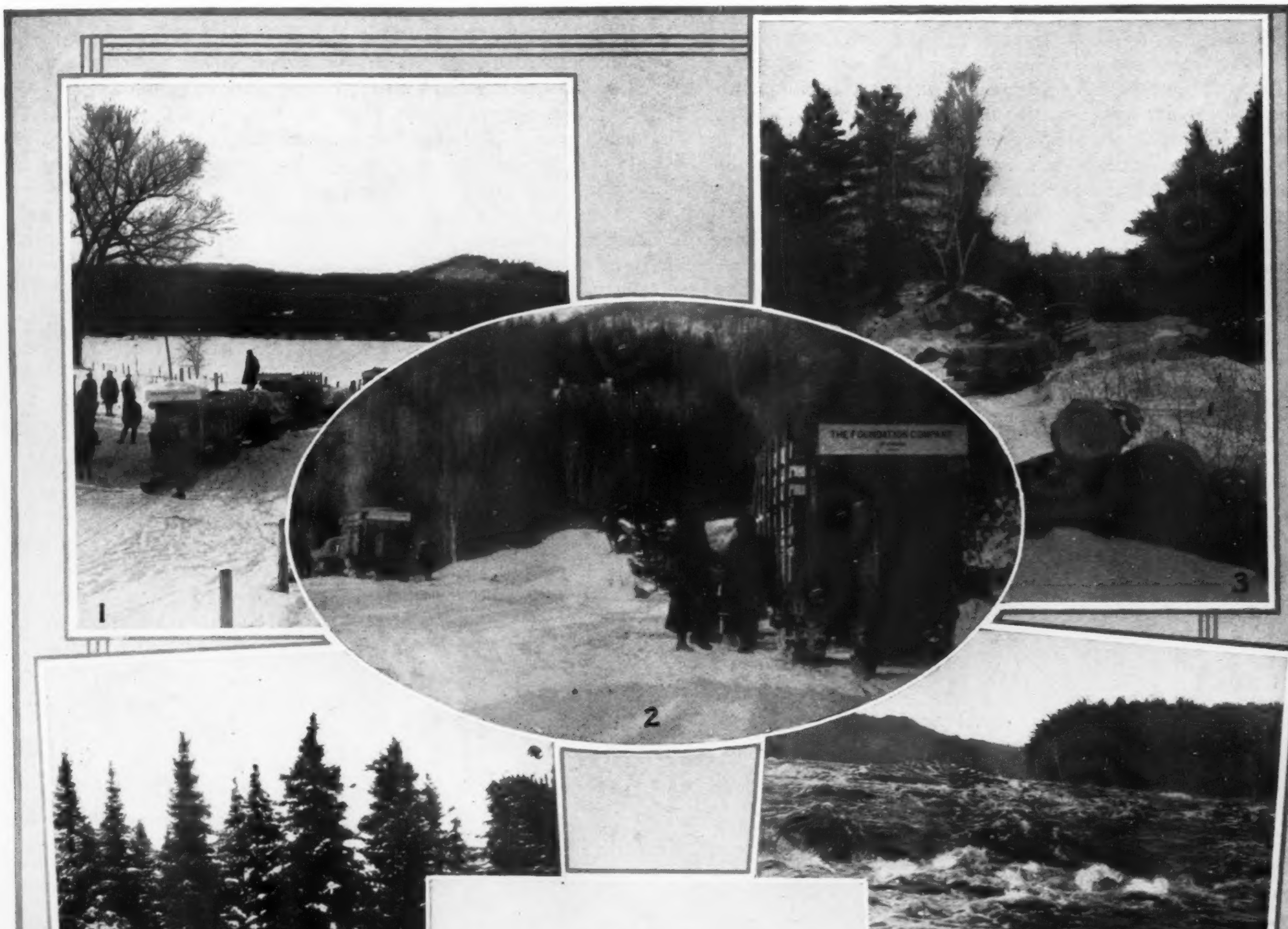
Obviously, to make the stream yield its maximum potential power, the flow had to be more or less equalized by impounding a measure of the great volume of water liberated during the spring thaws and by releasing it during the low-water period in the summer. This led to the creation of the Lake Baskatong storage system—an engineering feat of the first magnitude.

Lake Baskatong is about 120 miles upriver in a region that forms a natural basin for the impounding of water. The key of the entire system is the great dam at Bitobee, which, when closed, will create a lake with an area of more than 100 square miles and capable of impounding 82,000,000,000 cubic feet of water for use during the low-water season. It is expected that the regulated release of this water will result in a normal stream flow of about 10,000 second-feet. The drainage area tributary to this system, all of which has been surveyed, is about 6,200 square miles in extent.

The Lake Baskatong storage system is an interesting example of work carried on rapidly over a wide area despite serious obstacles, such as long hauls of materials and machinery, cold



Left—LaCroix Creek Dam. Right—Bitobee Dam.



1, 2, and 3—Tractors hauling stores in the wintertime to the site of the Lake Baskatong storage reservoir.
4—A forest of spruce which will furnish raw material for papermaknig.
5—Portable I-R compressor mounted on a sled to facilitate rapid shifting in the wintertime.
6—The turbulent Gatineau which is being harnessed at several points to furnish an aggregate of more than 400,000 h.p.
7—Linn tractors have played a big part in moving materials and other supplies from railhead to construction camps on the Gatineau River.

weather, etc. The system comprises four distinct dams—three of concrete construction and the fourth of earth fill—situated some 30 miles or more away from railhead, at Maniwaki, and on each side of the river. A bridge across the Gatineau at any point convenient for the transportation of the machinery and supplies necessary in the construction of the dams would have cost approximately $250,000; and as it would have taken eight months and more to build a

Dupras & Colas, Montreal.
Brigadier General J. B. White, Vice-president of the Canadian International Paper Company.

© Bachrach.
Allen Curtis, Vice-president of the International Paper Company.

railroad, that form of transportation was also out of the question if contract conditions were to be met.

After careful consideration, The Foundation Company of Canada, Ltd., the contractors for the storage system, decided to use large Linn tractors for hauling. Two tractor routes were accordingly laid out on opposite sides of the river from Maniwaki to the various dam sites. Over these routes, comprising ordinary farm roads and some 65 miles of new roads, 35,000 tons of machinery and supplies were taken to the dam sites.

The Bitobee Dam is mainly responsible for the control of the system; and for the regulation of the flow of the water are provided 12 Stoney sluice gates and 18 underwater sluice gates. The La Croix Creek and Castor Lake dams are of the gravity type of concrete construction, with one regulating gate. The Philemon Lake dams consist of four earth-filled sections. The quantities of materials excavated and handled in building these dams are: rock excavation, 34,674 cubic yards; earth excavation, 50,287 cubic yards; rock-filled sections, 6,656 cubic yards; earth-filled structures, 127,325 cubic yards; rip-rap work, 7,673 cubic

Archibald R. Graustein, President of the International Paper Company.

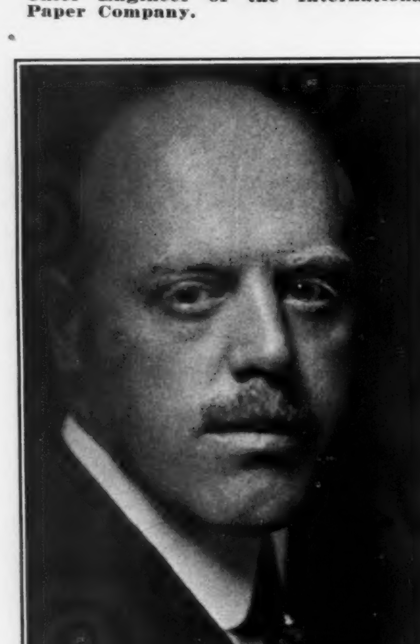
yards; and concrete for the dams and the approaches, 127,325 cubic yards.

Operations on the Lake Baskatong storage system were begun in December, 1925; and the contract stipulated that the project should be finished in the spring of 1927. This called for speed of execution; and the extensive application of labor-aiding appliances has contributed much to this end. Another factor that enabled work to be started quickly and to be carried on without frequent interruptions was the oil-electric power plant established at the main Bitobee Dam. During the early stages of the work, this plant—comprising three 165-h.p., semi-Diesel oil engines, connected to alternating-current generators—bore the burden of furnishing all the necessary power.

Later on, the power so supplied was supplemented by current from the Gatineau Power Company's plant at Carbeau, south of Maniwaki. A transmission line, 28 miles long, was especially built for this purpose. Over this line, current at 26,000 volts was delivered to a powerhouse at the Bitobee Dam site. Subsequently, the oil-electric plant and the Carbeau hydro-electric station were hooked up so that power could be supplied from either source. The oil-electric plant proved very useful for stand-by service during interruptions incident to starting up the new Carbeau powerhouse.

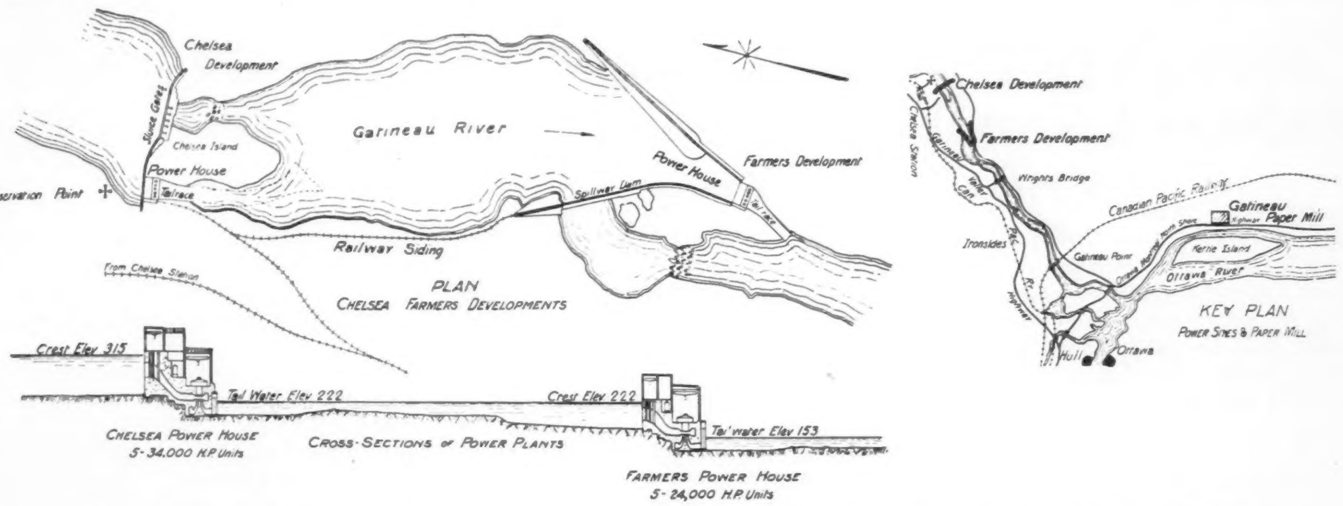
From the central power plant at the Bitobee Dam, current was transmitted at 6,600 volts to each of the other dam sites. At the Bitobee Dam a 14 and 9x12-inch ER-2 compressor and a 12x10-inch ER compressor were the

A. H. White, Vice-president and Chief Engineer of the International Paper Company.



G. Gordon Gale, General Manager of the Gatineau Power Company.

main sources of air power for operating rock drills, oil furnaces, sharpeners, riveting hammers, etc. The power plants at the La Croix Creek and Castor Lake dams were each equipped with one 14x12-inch EL-2 compressor. A 9x8-inch portable compressor was used as an auxiliary at each of the three dams mentioned, and these units were found particularly useful



General scheme and some details of the hydro-electric developments and new paper mill on the Gatineau River.

at the outlying ends of the dams which could not easily be reached by the regular air lines. The portables also served to keep the drills going when, for any reason, the electric current failed.

The total capacity of the various compressors employed in building the storage system was around 2,700 cubic feet per minute, while the combined capacity of the units on the reservoir, paper mill, and powerhouses was in the neighborhood of 12,000 cubic feet per minute. All rock drilling was done with machines of the "Jackhamer" type; and the steels were heated in oil furnaces and sharpened with "Leyner" sharpeners. A quarry was opened up at each dam site. Air for the "Jackhamers" used in these quarries was furnished by the compressor plants just mentioned.

(To be continued)

CANVAS TUBING FOR MINE VENTILATION

IN discussing mine ventilation at a meeting of the Ventilation and Dust Officers of South Africa, C. F. Raney said that canvas tubing for use with small fans has been adopted there exclusively as a result of tests extending over a period of several years. It was determined that air traveling at high velocities heats about twice as fast in galvanized-iron as in canvas tubing. Furthermore, a fan of given capacity can deliver more air to the face through canvas tubing than through metal tubing. And in this connection it should be remembered that many ventilating lines are more than 5,000 feet long. Other advantages in favor of canvas tubing are: elbows are not required to turn sharp corners; little trouble is experienced in carrying the tubing to the working face; and the cost of installation is comparatively low.

Cross sections and downstream elevation of Bitobee Dam.

Vacuum Fumigating Plants

Defense Against Foreign Plant Diseases and Insect Pests

By C. F. POOCK and I. GLEASON

KEEPING watch at our border lines and ports to prevent the entry into the United States of harmful bacteria and insect pests of one sort or another is a task of outstanding importance and one that becomes increasingly difficult to handle. According to Government experts, "The warfare against these pests grows more tense and more scientific year by year. To prevent the entry of new plant pests of all kinds, some 22 quarantines—either prohibiting or restricting and safeguarding the entry of products known to be likely to carry such pests —are now being enforced. This enforcement involves the maintenance of an inspection service at all important ocean and border ports of entry into this country.

"The important products thus brought under restrictions as to entry include cotton, various cereals, nursery and ornamental stock, and all fruits and vegetables. This service has been largely developed during the past four years, and it is significant to note that since the plant quarantine law was passed not a single new major pest has entered this country." To give the reader an idea of what this service means, let us consider the work done by the Government along the Mexican border, where a rigid control is maintained especially to prevent the further entry into Texas of the pink bollworm that is so destructive to cotton. In one year, upwards of 29,000 freight cars had to be inspected, and of these 17,000 had to be fumigated. In addition, all vehicular traffic out of Mexico had to be inspected and safeguarded. A fee covering actual cost of labor and chemicals was charged for the disinfection of such cars and vehicles—the receipts, amounting to $67,730.50, being turned into the Treasury.

In the past, the problem of fumigating bulk commodities has been attended with a measure of uncertainty. No matter how rigidly the regulations were enforced, one could not always be quite sure that the goods so treated and passed by the inspector were free from all undesirable insects and organisms. As a result, much thought has been given to the matter of fumigation; and experiments in recent years have led to the use of what is known as vacuum fumigation.

By this process, all the air is removed from the interior of packages, bales, boxes, barrels, etc., containing foodstuffs or other products subject to inspection under the quarantine regulations. This is done so that the fumigating gas can thoroughly penetrate the entire mass. Only in this way is it possible, so it is said, for the deadly gas to get to the heart of things, to search out, for example, certain of the boring insects that go deep and that cannot be reached in any other way.

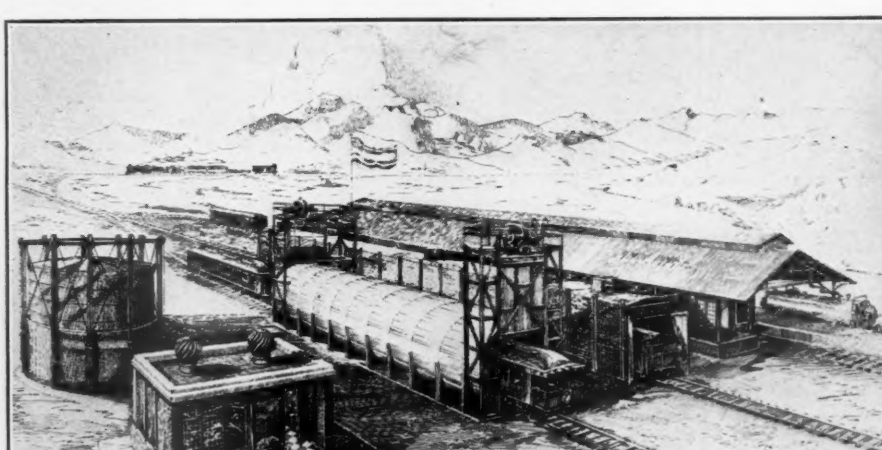
To accomplish this, the commodities to be fumigated are placed within a vacuum-tight steel chamber in which a 28-inch vacuum is produced by means of a vacuum pump. This partial vacuum should be developed within a period of not more than 8 minutes, preferably in less than 5, so that any hidden insect eggs may be burst open and destroyed by the sudden drop below normal pressure. This is one of the outstanding features claimed for the California Vacuum Fumigator, the type under consideration. While the chamber is under a vacuum, a mixture of lethal gas is admitted. The action of this gas is such as to kill all forms of insect pests that may infest any of the commodities undergoing treatment.

Where a whole train of empty cars is to be fumigated, the practice is to liberate a certain quantity of deadly gas into the surrounding air. In the case of atmospheric fumigation of this sort, the cyanide gas used is wasted. That is, whatever does not escape through the brick walls of the fumigator is blown out by a number of fans after the doors are opened. On the other hand, the vacuum chamber is so arranged that the gas employed can be pumped back into the gas holder for re-use.

The fumigating plant shown in the accompanying illustration was designed by the Union Tank & Pipe Company, of Los Angeles, Calif., as an international quarantine station to be so located in relation to boundary lines that all shipments entering by rail could be conveniently subjected to fumigation upon the demand of the inspection officers.

The advantage of any dependable system of fumigation cannot be over-estimated, if we take into account the tremendous losses we have and still are suffering from plant diseases and insects that were brought to us in consignments from abroad and that have gained a foothold here. Aside from these losses, the Government has spent millions of dollars in trying to exterminate these pests.

International fumigating plants, placed at strategic positions at ocean and border ports, might be used not only to give incoming but also outgoing goods a clean bill of health, thus doing a service that would be of benefit to ourselves and to our foreign markets.



Drawing by C. F. Poock.
Type of fumigating plant designed to protect fruits, vegetables, and flowers in the United States from alien insects and plant diseases.

LOOK FOR LEAKS

AN unaccountably heavy increase in the consumption of water in Philadelphia recently led the municipal authorities to undertake a pitometer survey to locate the cause. So far, leakage amounting to 2,000,000 gallons a day has been revealed and remedied—one leak alone having been responsible for a loss of 700,000 gallons daily. This large leak had given no sign of its existence, as the water had found a convenient outlet by way of a sewer connection.

Here is an object lesson that might well be applied with profit in other directions, such, for example, as in the case of compressed-air lines. Even small leaks, especially if numerous, are apt to permit the escape of a large volume of air that has been produced at an expenditure of power. As air lines are generally accessible, they should be frequently and systematically inspected.

Fine Example of Railroad Enterprise

Locomotive Shops at Tampa Splendid Evidence of Foresight on Part of Atlantic Coast Line Railroad

By S. G. ROBERTS

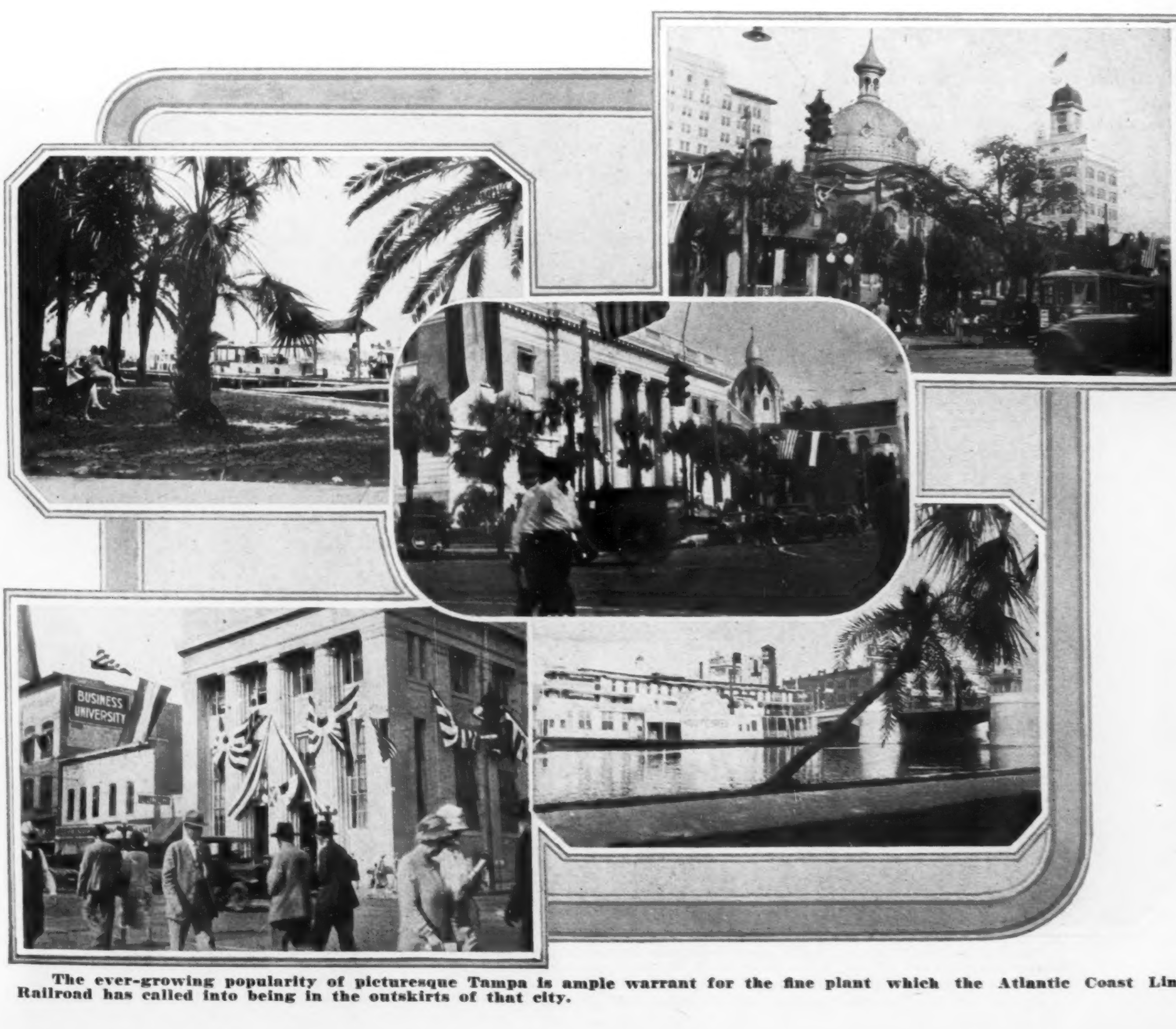
THE Atlantic Coast Line Railroad has spent approximately $2,000,000 in building and in equipping its splendid modern locomotive- and car-repair plant on the outskirts of the City of Tampa, Fla. In thus creating a model establishment of this kind in the Southland, this enterprising and up-to-date railroad has given ample evidence of its faith in Florida's ability to stage a sound economic comeback.

Before the plant was undertaken, the railroad got along as best it could with small and inadequate shops at Port Tampa; but a steadily increasing volume of business and the continually growing importance of the road in the industrial and business life of Florida, induced the management of the Atlantic Coast Line to erect suitable shops at Tampa.

The energy displayed in making the shops speedily ready for service will be realized when it is recalled that the contract was signed in May, 1926, and the main shop structure was finished and operating within the notably brief span of 8 months—the plant beginning to make repairs on January 3, of the current year.

What has been done at Tampa is another example of the spirit pervading all departments of the Atlantic Coast Line, and is the present climax of a development that has been watched with keen interest by students of America's railroads. The Atlantic Coast Line is the outcome of the unification of a number of roads—some of but little importance when they existed separately—that have been coördinated and organized into a system that is recognized as one of the foremost among the railroads of the country. No small part of this growth and evolution is due to the fine spirit of loyalty that actuates the personnel from the highest to the lowest ranks of the organization. In short, the personnel forms a great industrial family—the children of the older generation following in the footsteps of their fathers in taking over and in carrying on the work of the road. This has been the case in increasing measure for fully half a hundred years. As has been well said: "In such an organization, harmony must prevail; and where harmony is paramount, service and efficiency naturally follow."

Efficiency is the outstanding keynote in the shops at Tampa. To begin with, the boiler shop, erecting shop, machine shop, blacksmith shop,



The ever-growing popularity of picturesque Tampa is ample warrant for the fine plant which the Atlantic Coast Line Railroad has called into being in the outskirts of that city.

Left—Racks where compressed air is used to test air-brake equipment.
Right—In the blacksmith shop compressed air performs many services.

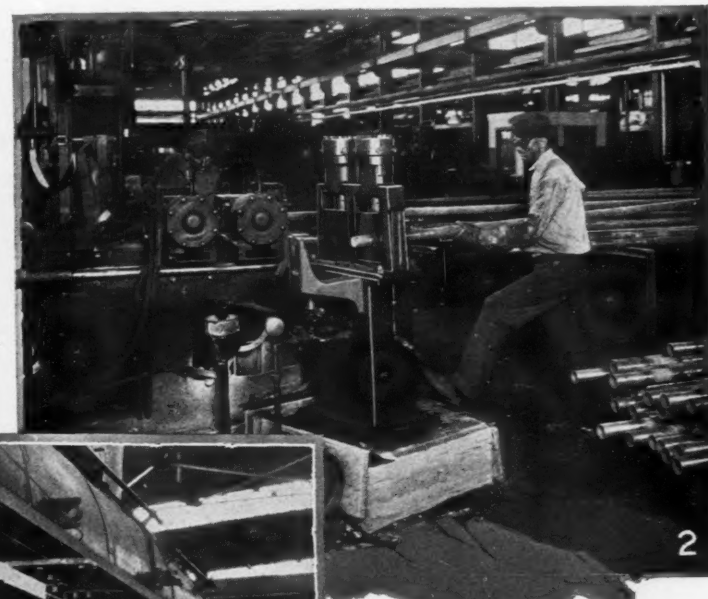
etc., are all housed within one monster building that covers a ground area of 4½ acres. This close association of the various essential departments of the plant makes interchange and coördination of work relatively easy; and, further to facilitate this, there are no fewer than 13 traveling cranes within the great structure. These cranes range in lifting capacity from 3 to 100 tons; and all are actuated electrically.

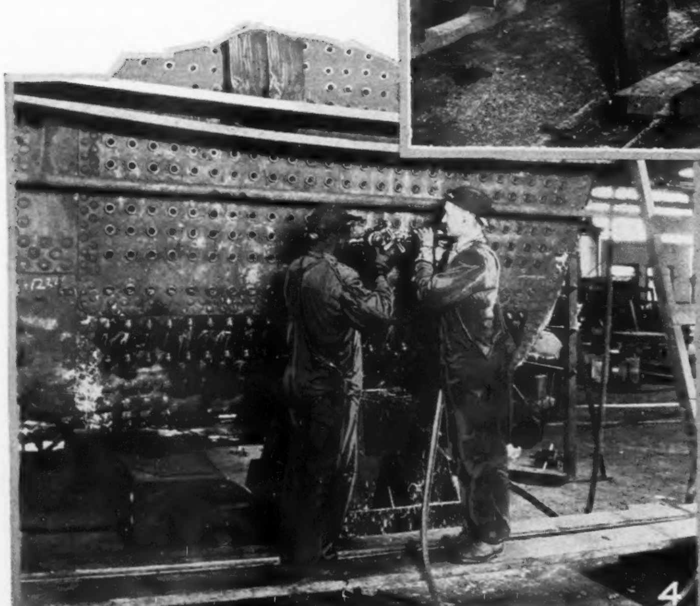
To still further reduce lost motion to the lowest practicable degree, all work in the shop is "parked"; and to promote the prescribed flow of the work, the parking places for materials and work in various stages of completion are indicated by 3-inch metal strips fastened to the floor. In this way all work is routed, and all finished work is delivered at a single place. A messenger service is maintained between the different machines and the tool-dressing room. This service makes it unnecessary for any machinist to leave his machine and to go to the tool room. Furthermore, the machines are arranged in line and in sequence so that operations may be taken in hand successively and with the shortest practicable movement between each stage toward completion.

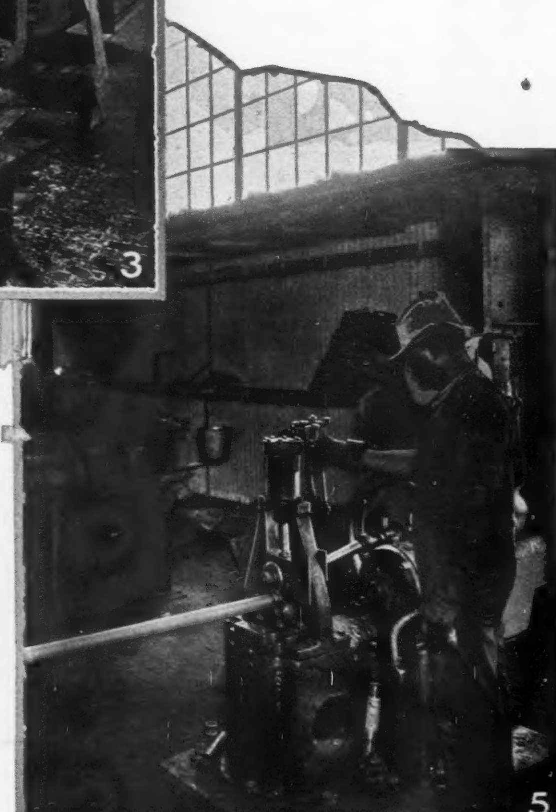
The operator's name, on a plate, is attached to his machine—the object being to identify the man with his machine, to promote a feeling of semi-proprietorship, and to arouse a sense of personal responsibility. On Sunday of every week, the General Foreman makes an inspection of the shop equipment; and each week the man at each machine will get a merit mark if he deserves it. Those commended will have their names posted every Monday morning on the "Merit Board." A man winning a merit star for four weeks in succession will receive a letter of commendation from the General Foreman. Those that do not win commendation will be called upon to explain why their machines have not been kept in proper condition. As the General Foreman expresses it: "I want the men to take the same pride in their shop machines as they do in their homes." Cleanliness in dress is also encouraged, because pride in personal appearance is very apt to be reflected in pride of performance. To promote cleanliness generally, the shop is not allowed to become untidy at any time—a number of charwomen being kept busy the day through in sweeping the floor and in disposing of small scrap or refuse of any sort.

At the present time there are 370 employees in the new shop, and about 700 men in all departments of the associate plant. During the month of May of the current year, 18 engines were turned out of this shop. Two of these received new fire boxes, and on a number of them the repairs came under Classes Nos. 2½, 3, 4, and 5. The shop employees very rightly feel proud of that performance with a force of fewer than 400 men and in only the fifth month of the active operation of the plant. The force will later be augmented, as occasion demands, so that from 25 to 30 locomotives can be handled every month—the machine-tool equipment already installed being ample for that purpose. There is sufficient space left in both the heavy and the machine-tool bays of the machine shop for a 25 per cent. increase of machine tools; and the great building is so arranged that galleries and additional crane service can be provided to take care of another

Left—North front of the main shop building showing provisions for natural lighting and ventilating.
Right—South face of the main shop with locomotives awaiting repairs.







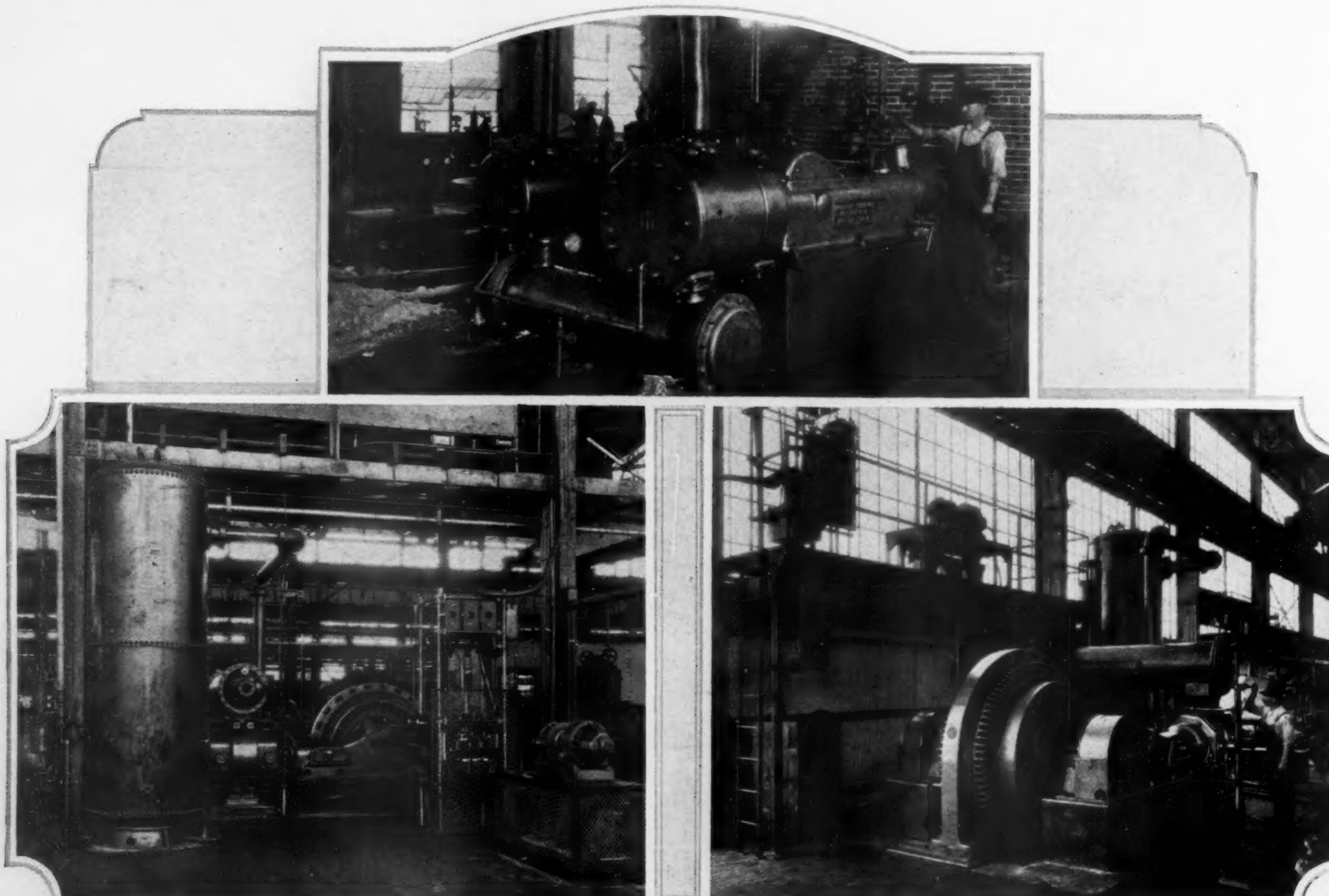
1—Air-driven grinder finishing the main rod of a locomotive.
2—This pneumatic hammer is used on boiler tubes after they have been welded.
3—Reaming holes in a locomotive frame with an I-R close-quarter drill.
4—Tapping stay-bolt holes in a locomotive fire box with an I-R pneumatic drill.
5—In this flue-cutting machine the feed is controlled by compressed air.

25 to 30 per cent. increase. That is to say, when necessary, it will be entirely practicable to shop from 40 to 50 locomotives in the course of a month without enlarging or adding to the existing main building. Should still greater housing facilities be required later on, there is ample ground space available so that the present structure may be extended and its capacity amplified 60 per cent. So much for the forethought displayed by the management of the Atlantic Coast Line Railroad in preparing for future demands that will inevitably be made by merchants and by industry in Florida and by passenger traffic bound to and from this land of winter sunshine and perennial verdure.

tracks provided for it that carry it to the flue rattler. The whole set is then picked up by an outside gantry crane and set on a structural steel platform—rolling onward into the rattler drum by gravity. A spray of water, entering this drum, keeps down the dust. When the flues are thoroughly clean, the doors on the rattler drum are opened, the flues roll out on to the steel platform, and are carried by gravity into the flue trucks. The flue trucks are then rolled into the flue-welding department. Each flue is first cut off at one end by a motor-driven, air-operated-feed flue cover. The work is completed in seven additional stages—the last one consisting of emersing the tube in water and testing it with compressed air. With

ment equipped with oil-operated forges and furnaces and with a mechanical blacksmith's hammer.

All castings and all materials classed as outside materials are tagged and neatly stacked on platforms along both the north and the south sides of the building, where they are served by 10-ton gantry cranes running the entire length of the structure. A very noticeable feature of the gantry cranes is an extension on each that permits a crane to reach over a car and pick up a load and then bring it back between the legs of the gantry. A large space in the main building is partitioned off to serve as a storeroom in which are placed small parts and materials necessary for the general



Top—Steam-driven compressor, in the roundhouse annex, which furnishes air for use in the roundhouse machine shop and, at night, to the yard air lines.
Bottom—The two big electrically driven compressors in the main shop that alternate in providing compressed air for a multiplicity of services during the daytime.

The boiler shop is located in the northwest corner of the great building, and is equipped with typically up-to-date boiler-making machinery. All fire-box and superheater work is handled in the north end of the large erecting bay, where there are fine crane facilities. This shop is provided with an ample assortment of air-operated tools, such as pneumatic drills, air hammers, and air-driven rivet busters of the latest and best designs.

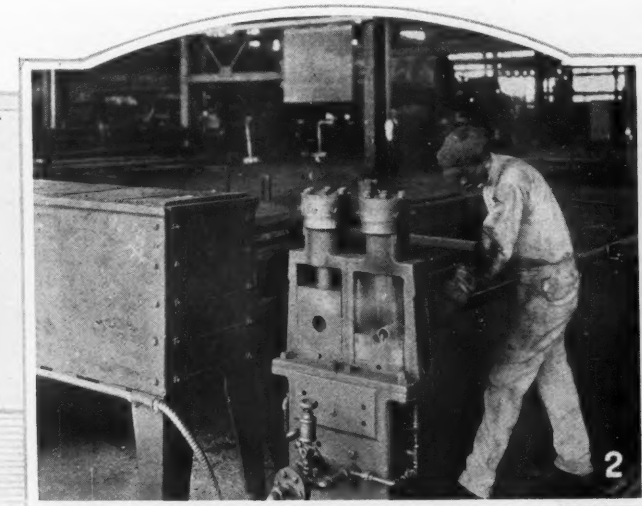
The method of handling flues is unique, and calls for a minimum of hand labor. Flues are cut out of the boiler, and the whole set is put on a special roller-bearing flue truck. This truck is either lifted by crane or rolled on

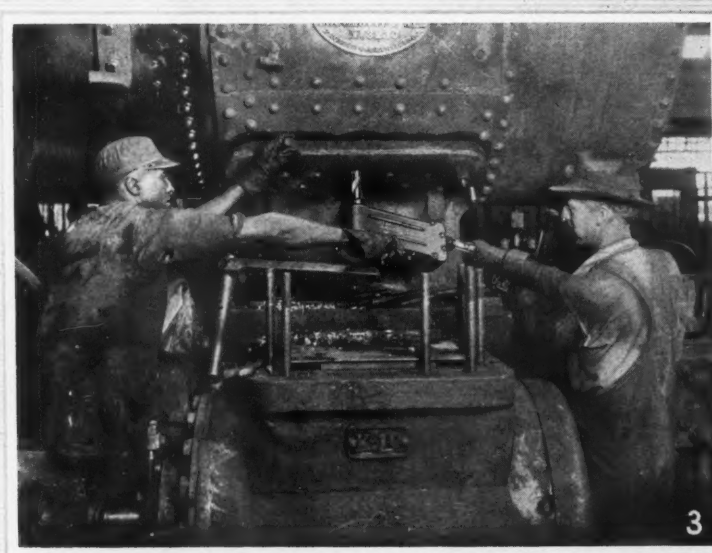
the eighth operation finished, the flues are rolled into flue trucks and are then ready to go back in boilers. The work is a continuous cycle, and everything is so arranged that there is no lost motion.

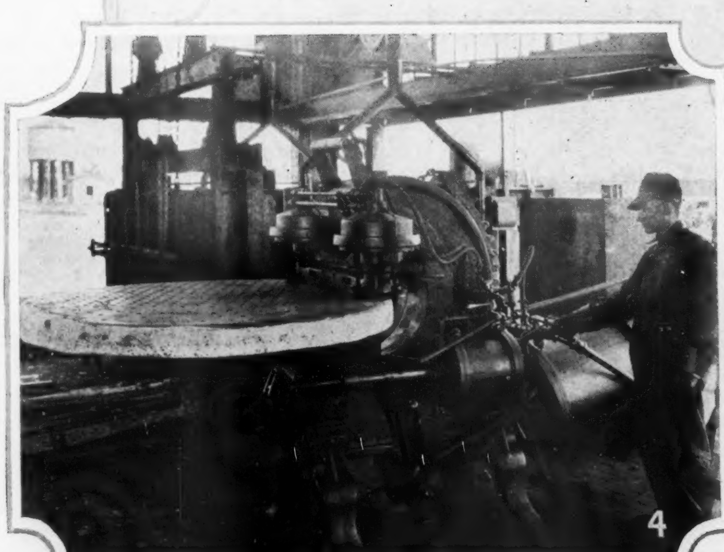
The blacksmith shop is something of an innovation and modern in every particular. There are no coal forges—all forges and furnaces are heated with oil burners, and each has its own motor-driven blower mounted on a neat platform above the forge and far enough away not to be affected by the heat. The shop is well served with cranes, steam hammers, and power hammers. All tool work is done in a special tool-tempering depart-

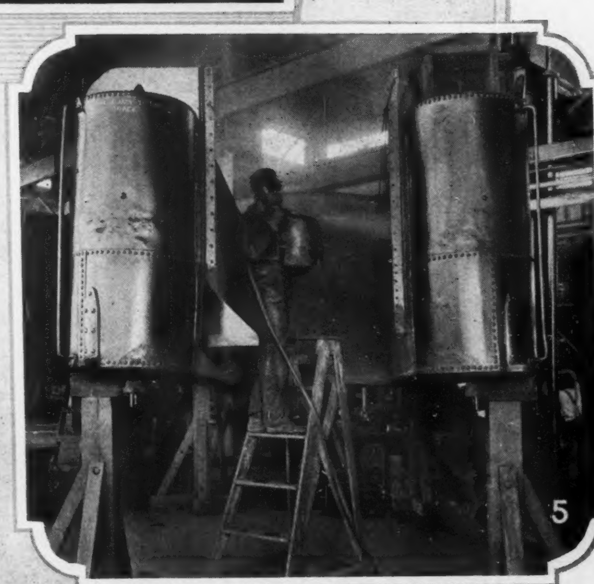
run of locomotive work. All these are properly tagged for identification and stock-keeping purposes and are stacked in standard racks. This is independent of the main storehouse.

As far as can be done so advantageously, all machine tools and other essential equipment in the shops are driven by electricity; and the electrical installation at Tampa is one in which the management takes pardonable pride. Indeed, the manner in which care has been taken to safeguard every part of the electrical system has occasioned much commendatory comment from competent authorities. The primary purpose is to prevent the system from going wrong under a wide range of service conditions, and



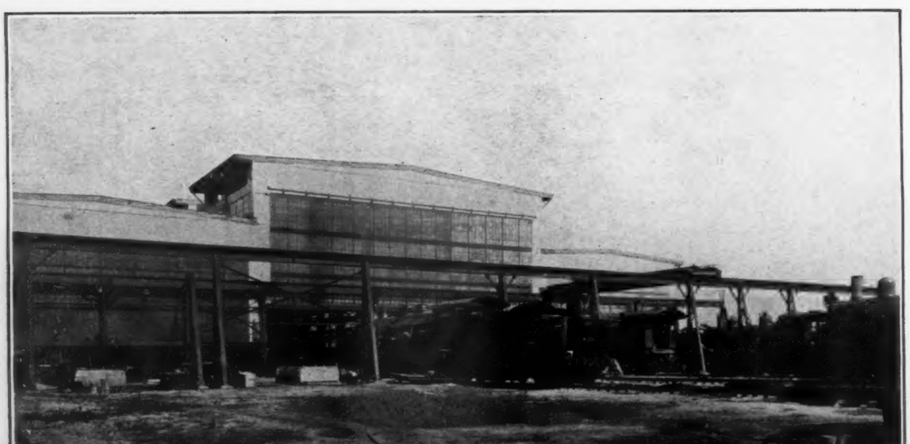




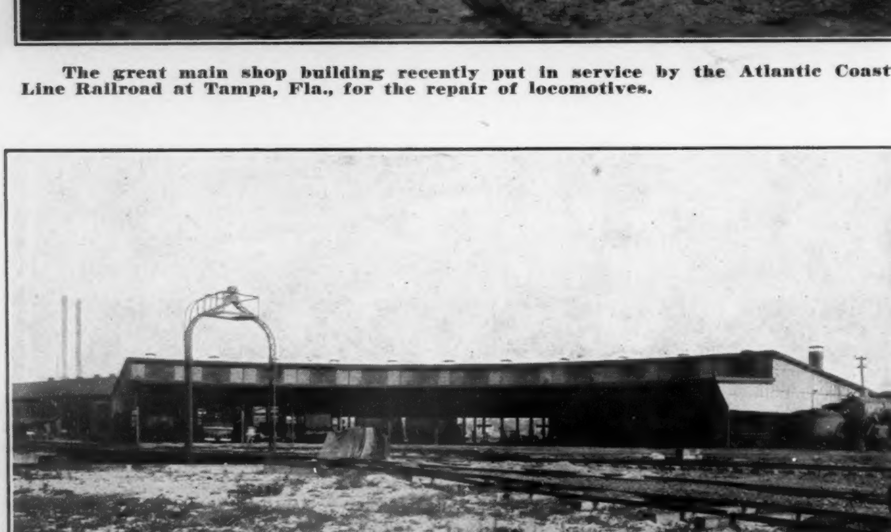


1—Air-operated flanger bending a piece of boiler plate.
2—Swedging a boiler tube with a pneumatic hammer.
3—Drilling bolt holes in a locomotive cylinder saddle.
4—Pneumatic flanger at work on a flue sheet.
5—Finishing locomotive tanks with air-sprayed paint.

This model locker and washroom is one of the features of the Tampa plant of which the management is rightly proud.



The great main shop building recently put in service by the Atlantic Coast Line Railroad at Tampa, Fla., for the repair of locomotives.



The roundhouse at Tampa has 12 covered stalls; and, adjacent to it, are 13 uncovered stalls for locomotives.

then to protect the installation from interference by inquisitive or unqualified persons.

As explained by Mr. C. R. Sugg, Electrical Engineer of the Atlantic Coast Line: "Electrical energy is delivered to an outdoor substation at 4,000 volts, and is there stepped down to 440 volts, for power requirements, and to 220 and 110 volts for lighting. In the power-wiring layout, the use of fuses has been avoided wherever practicable. The power wires enter the building at one point, at which location air-brake circuit breakers with inverse time-limit overload protection are installed in place of fused switches. These circuit breakers are on a gallery, and no one but an electrician is allowed on that gallery. From this point the wiring is carried overhead and distributed to several locations. On other platforms, elevated about 15 feet above the floor, are additional centers of distribution where the wiring passes through air-brake circuit breakers—of the same type as those used at the entrance—to a bus bar. From this bus bar the wiring is carried through unfused, knife-blade disconnecting switches and remote control starters. Wherever practicable, these switches and starters are located on the gallery—the only electrical equipment on a machine so controlled being the motor and the push button."

Because all switchboards and controlling apparatus are kept overhead and out of the way of careless persons, or those inexperienced in electrical matters, the essential power control and distributing systems are effectually isolated and safeguarded from interference—intentional or otherwise. This feature of the plant has appealed forcibly to many visiting inspectors from other railroads. All machines in the main shop are motor driven by individual motors—there are no countershafts.

Among the various machines driven by electricity in the main shop are two air compressors, each of which is capable of delivering 1,500 cubic feet of air per minute. At present, only one of these machines is run at a time—the other serving as a standby unit; but as soon as the plant is working at capacity, both compressors will be used simultaneously to furnish all the operating air that will be required for numerous purposes within the main shop building as well as outside in the yard. These units are a source of much satisfaction to the management; and in speaking of them the superintendent recently said: "They are certainly sweet machines!"

Compressed air is utilized in many ways in and about the Tampa plant. It provides motive force for pneumatic tools of different kinds required in repairing locomotives and for many odd jobs around the shops; it is essential in sandblasting to remove paint; it is used in connection with paint-spraying outfits; it operates air hoists; it functions drop-pit jacks; and it is employed with oil flames that heat locomotive tires for removal or for refitting. Compressed air operates the sanitary ejectors; and compressed air is also used by flue cutters, pipe-bending machines, flanging machines, for flue testing, in grease presses, in siphoning oil from barrels, in testing air

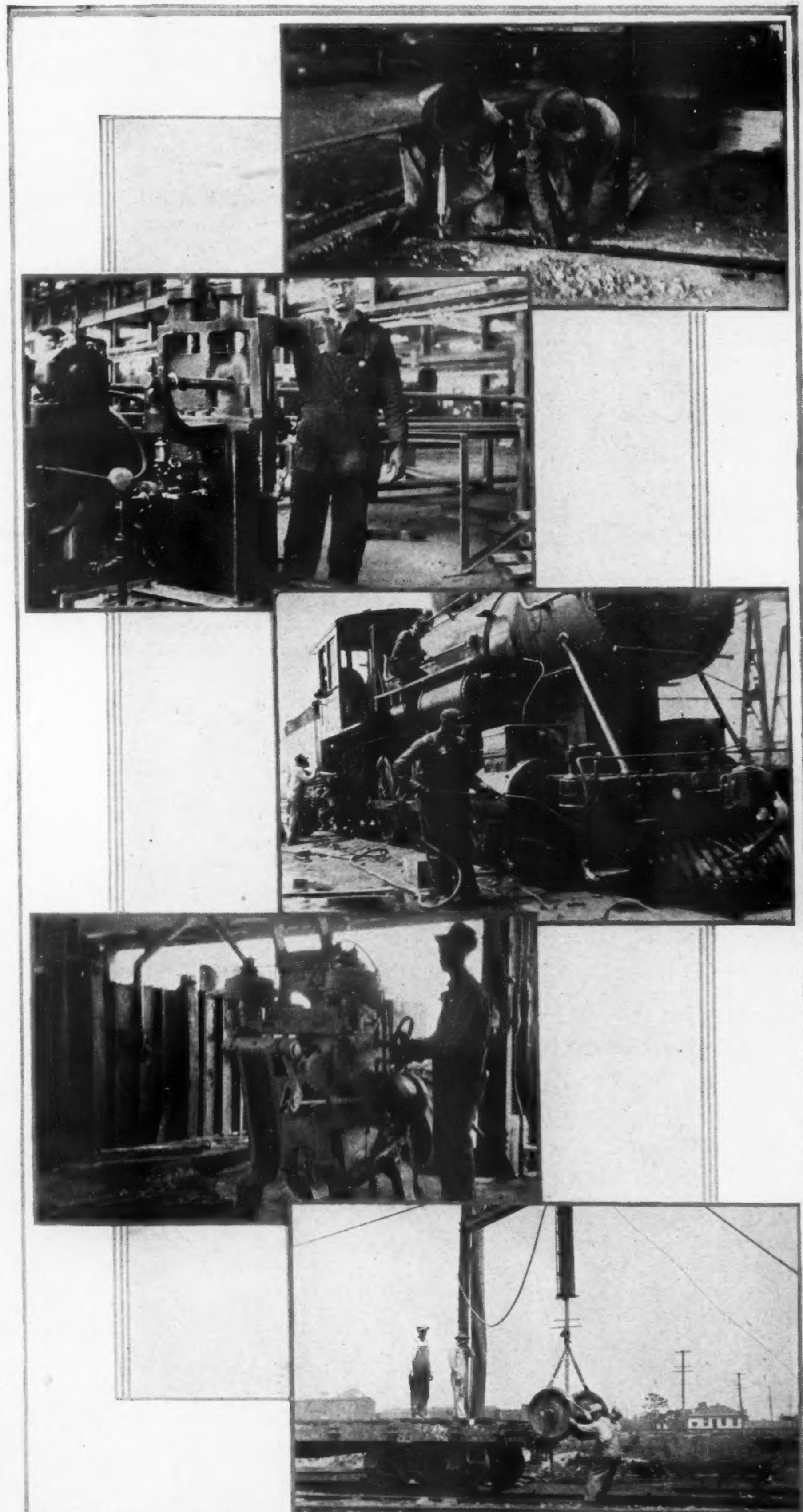
brakes, in cleaning electric motors, and in operating air lifts in certain of the wells on the premises. Finally, compressed air is extensively employed in the train yard for testing brakes, cleaning coaches, and doing a number of other necessary labor-lightening things. As is usually the case in shops of this sort, compressed air is drawn upon to perform various duties that develop from time to time where fertile-minded workmen devise handy and ingenious methods by which to speed up performance.

At the Tampa plant, both light and heavy repairs are now made on approximately 800 cars and coaches every month. Within the main building, at strategic points on the floor, are placed what are known as "service boxes." These boxes house compressed-air, oxy-acetylene, and electric-power and light connections, so that any one of these can be readily hooked up to meet a need nearby. These service boxes are conveniences that obviate long hose or long cables in supplying gas, air, or electricity for work anywhere on the shop floor in overhauling or repairing locomotives.

All water used for drinking is obtained from an Artesian well 600 feet deep, having a natural flow. Water for locomotives comes from four Artesian wells from which it is raised to the surface by air lifts. One of the features of the plant is a fine locker room with sanitary wash basins that are supplied with hot and cold water. There is also a well-equipped emergency hospital of ample size to meet ordinary demands. Serious accidents are infrequent, mainly because the management is tireless in preaching the gospel of "safety first." The whole plant has a thoroughly modern fire-protection system. A 1,000-gallon-per-minute electric pump, driven by a 50-h.p. motor, serves the fire line. There is also a 750-gallon steam pump as an emergency standby.

Adjacent to the main shops is a roundhouse having 12 covered and 13 uncovered stalls; and for this roundhouse there is a turntable 100 feet long. The roundhouse has a modern concrete coaling station of 500 tons capacity. This coaling station is automatic in its operation, and handles about 250 tons of coal a day at a cost of approximately 2½ cents a ton. Two clinker hoists are located on incoming tracks for handling cinders; and there is also an air-operated device for filling the sand boxes on locomotives. An annex to the roundhouse is equipped with facilities to take care of the usual run of machine work in connection with the routine handling of locomotives. The roundhouse, with its associate machine shop, handles from 1,000 to 1,200 locomotives in the course of a month. The roundhouse has a steam-driven compressor which is usually relied upon to furnish air in the yard during the night when the electrically driven compressors in the main shop building are shut down. The yard force looks after 11 passenger trains daily—the yard being the terminal for all passenger trains entering and leaving Tampa.

A fine brick building has been erected by the company to take care of the road and engine crews while lying over at the terminal. This building is provided with shower baths,



Air-driven chipping hammer excavating in shop floor.
Pneumatic swedging hammer at work on boiler tubes.
Spray painting a locomotive truck.
Air-operated flanging machine.
Air hoist handling car wheels.

wash and locker facilities, and rooms and beds in sufficient number to accommodate 84 men. An attendant keeps this building in first-class condition.

To appreciate just what the Atlantic Coast Line has called into being at Tampa it is necessary to visit the place both to see how well the plant has been provided with up-to-date equipment and how that equipment has been disposed so as to contribute to efficient and expeditious performance of work. Finally, only by such a visit can one understand the splendid spirit of coöperation prevailing in every department of the establishment. This spirit is in large part due to the attitude of the management.

Mr. James Grant combines the double office of Shop Superintendent and Master Mechanic. Besides being thoroughly capable, he is genial and, withal, a kindly disciplinarian. He maintains what he calls an "open office"—that is, any of his employees or subordinates can walk right in provided the man has a reasonable excuse for doing so. Mr. Grant's first assistant is Mr. W. C. Stephenson, General Foreman. Mr. Stephenson is a direct descendant of George Stephenson, the famous British pioneer locomotive builder; and, therefore, the present Mr. Stephenson comes by right of inheritance into his chosen field of service. Mr. E. W. O'Brien is Foreman of the erecting shop.

The layout of the whole plant and the placing and installing of machinery was under the direction of Mr. R. D. Hawkins, General Superintendent of Motive Power, Wilmington, N. C.; Mr. James Paul, Superintendent of Motive Power, Tampa, Fla.; and Mr. C. L. Meister, Mechanical Engineer, Wilmington, N. C. The main building was erected by the Dwight P. Robinson Construction Company of New York.

COMPRESSED AIR CLEANS CRACKS IN HIGHWAYS

JOBS that in themselves seem to be of little importance often stand out like the traditional sore thumb because they are so troublesome. As a result, heads are put together, and something is generally devised that takes the "cussedness" out of the work.

In repairing concrete pavements, the Oklahoma State Highway Commission found that the work could not be done satisfactorily simply because it was well-nigh impossible to clean the cracks between the old and the new sections preparatory to filling them with asphalt. To make a good joint, surfaces have to be clean, otherwise the liquid asphalt will not adhere to them and will fail firmly to bind the contiguous sections. Sharp-pointed picks were first used to loosen the dirt clinging to the surfaces, and then brooms of different kinds were employed without success in trying to get rid of all the foreign matter. Besides, three workers were sometimes required to do the cleaning in order to keep ahead of the man with the pouring pot.

What could be simpler for this purpose than a strong blast of compressed air? This was promptly tried; and, as a result, it now takes two men with pouring pots to keep up with one man and the compressor. The equipment as used consists of a small compressor mounted on an ordinary Ford truck and of a 60-foot air hose. One end of this line is connected to the air receiver while the other carries a pointed thumb nozzle that is 30 inches long and made of a piece of ½-inch gas pipe. Air at a pressure of 100 pounds is utilized.

Besides doing the work in a fraction of the time formerly required when brooms were employed, the blast of air obviates the need of picks and leaves the cracks thoroughly clean. According to W. H. Rhodes, the Maintenance Engineer of the Oklahoma State Highway Commission, "We estimate that this process has saved about 50 per cent. of the cost of labor on crack filling. Of the joints cleaned in this way there are practically none where the asphalt has picked up or peeled."

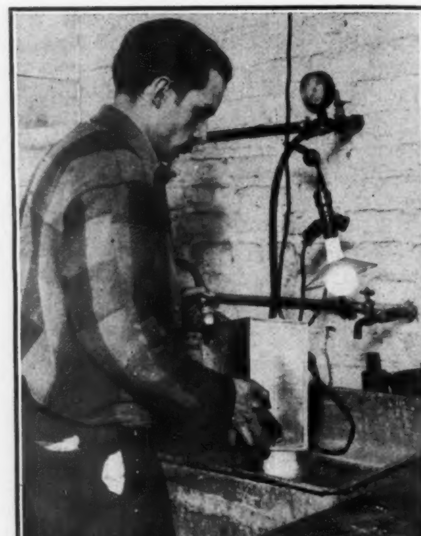
Courtesy, Engineering News-Record.
Air nozzle used to clean cracks in repairing concrete highways.

FINE PAPER FROM WORN-OUT GREENBACKS

HAVING succeeded in producing in its experimental paper mill an improved quality of paper for making paper money, the United States Bureau of Standards has reversed the process and produced a good quality of paper from the paper money after it has served its useful life. This work has been done in coöperation with the Bureau of Engraving and Printing and the Bureau of Efficiency to effect economies in Government currency expenditures.

The worn-out paper money returned to the Treasury Department for redemption, together with a small proportion of spoiled paper and trimmings from the currency printing plant, amounts to approximately 4 tons daily. At the present time this material is macerated at the Bureau of Engraving and Printing and sold in the form of pulp containing some 70 per cent. of water and practically all the ink—no attempt being made to clean the pulp. This pulp is suitable for coarse paper products only. For this reason the price received is so low that the maceration of the material is costing annually from $15,000 to $18,000.

As the original paper is composed of the highest grade linen- and cotton-rag fibers, it was believed that a clean pulp would have a ready market for fine writing and printing papers. Working along this line, the bureau has succeeded in producing a pulp suitable for these purposes. In fact, the recovered fiber paper is somewhat stronger than that made from new sulphite fiber and as strong as some grades of rag-fiber papers manufactured from the lower grades of rags. It is estimated that by thus improving the quality of the pulp, the present loss can be turned to a profit amounting possibly to $50,000 yearly.



© Ewing Galloway, New York.
The tightness of many thousands of tin containers is determined daily by filling them with air under pressure and then submerging them in a tank of water. Escaping bubbles instantly indicate any leaks.

Private capital in the United States has for sometime past been looking into the possibilities of producing helium on a commercial scale. It is believed that with the Government's present program of constructing lighter-than-air craft, and the probable commercial use of this type of airship, private enterprise would find a ready market for all the helium that it could produce. It has been reported that building operations on a helium plant are to be started somewhere out West this summer.

Compressed Air Safeguards Workers on Difficult Foundation Job

Marsh Gas was Struck in Carrying Open Wells for Cleveland Building to Record-Breaking Depths

By FRANK W. SKINNER

THE new $11,000,000 Terminal Tower Building, facing the south and west sides of Cleveland's public square, is notable not only because it is to be one of the tallest of office buildings but on account of the character and great depth of its foundation, the dangers and difficulties encountered in constructing it, and the unusual methods by which that work was done. The structure will be 52 stories high; and, with a 120x120-foot tower, will rise 708 feet above street level and provide nearly 13 acres of rentable floor space.

The foundation included 87 slender concrete shafts, from 4 feet to 10½ feet in diameter, some of which were carried down through plastic clay to bedrock lying at a maximum depth of 260 feet below the surface of the ground, thus making them by far the deepest open-pit foundation excavations ever dug. If placed end to end, these shafts would have aggregated about 2 miles in depth. In this work the contractor demonstrated a high degree of skill, not to mention courage; and despite serious natural obstacles and a 21-week labor strike he succeeded in finishing his part of the building operations without much delay, loss, or accident. It might be mentioned here that Spencer, White & Prentis, the contractor, specializes in this field of effort, and therefore brought to the job a wealth of experience and a well-organized construction plant. The foundation was completed in about nine months with a maximum working force of approximately 250 men and at an expenditure of $500,000.

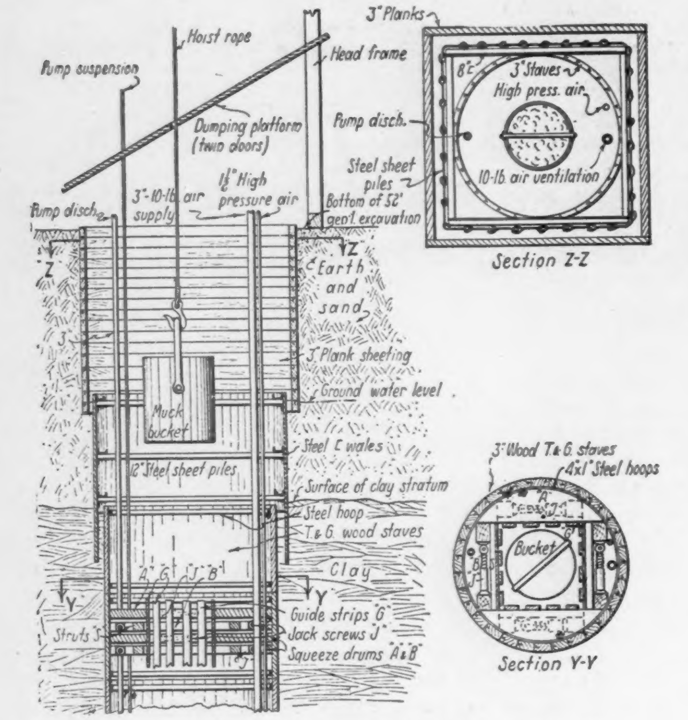
We are accustomed to associate the use of compressed air in deep and difficult foundation work with the sinking of pneumatic caissons, and in almost all construction jobs with the operation of air-driven tools and equipment which not only expedite progress but also reduce the cost and the amount of labor required. Although no pneumatic caissons were employed, a large quantity of low-pressure air was needed to ventilate the shafts; and this air was furnished by a compressor delivering 1,000 cubic feet of free air per minute at a pressure of 10 pounds.

The compressed air was distributed through 4- and 6-inch horizontal mains to 3-inch drop pipes. These were carried down to the bottoms of the deep wells and to points 50 feet higher where the air served to dilute, displace, and carry out of the pits large and variable volumes of dangerous methane or marsh gas that accumulated there generally at a depth of 190 feet and more.

The gas—being colorless, tasteless, and odorless—was a constant source of danger; but, thanks to the system of ventilation employed by the contractor, no explosions occurred; and the men were able to work continuously without discomfort or serious accident. Only on one occasion a stray spark ignited the flow of methane escaping by way of the mouth of one of the shafts, and this caused a number of men standing nearby to be burned severely enough to require hospital treatment. However, there were no fatalities. As a safeguard, there was always kept in readiness on the job a trained rescue gang equipped with stretchers, gas masks, and other first-aid appliances. For-

Courtesy, Cleveland Plain Dealer.

When finished, the great Terminal Tower Building will dominate Cleveland's public square.



Courtesy, Railway Age.
Sections showing typical features of a foundation well.

tunately, owing to the precautions taken by the contractor, the services of this emergency field force were never needed.

The wells, as already mentioned, were driven through a very thick stratum of hard and plastic clay, most of which was excavated by pneumatic clay diggers. These tools, together with paving breakers and "Jackhamers" required to do other essential work, were operated with air furnished by an I-R 9x8-inch Type Twenty portable compressor.

The foundation pits were started in earth and fill and were sheeted down to groundwater level with horizontal planks. From that point on downward, 12-inch Lackawanna steel sheet piling, having a maximum length of 25 feet, was driven to penetration in the underlying clay stratum by double-acting steam hammers. A total of 200 tons of steel sheet piling was required for this purpose. Through the clay, excavating was carried to a maximum depth of 210 feet below the bottom of the general steam-shovel excavation of 52 feet, thus making a total depth of 262 feet. The work was done by the standard Chicago well method—that is, the face of the clay was sustained by 4- and 6-foot vertical tongue-and-groove wooden staves, forming sections of cylinders, assembled around and within sectional hoops and bolted together through their radial flanges.

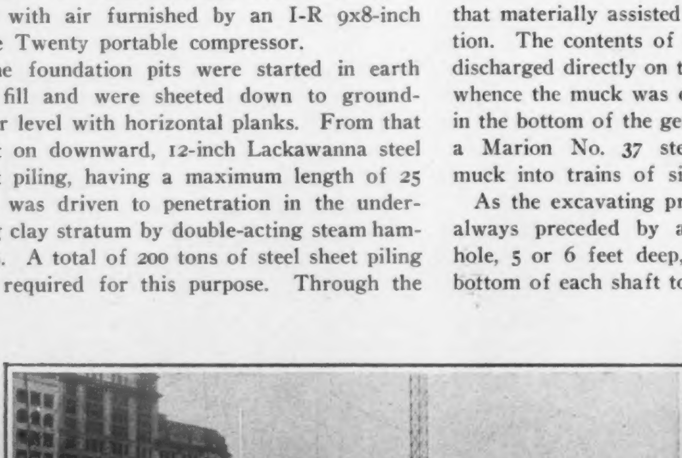
The spoils were loaded into cylindrical buckets, ranging in capacity from $4\frac{1}{2}$ to 27 cubic feet, which were hoisted at a speed of 100 feet per minute and more. The $4\frac{1}{2}$-foot buckets were handled by caisson winches, driven by 2-h.p. electric motors, that were capable of raising loads of 600 pounds on a single line. The larger buckets were handled by double-drum hoists, operated by 20-h.p. motors, which could lift a load of 1,500 pounds at a single-line speed of 200 feet a minute. These larger buckets had a diameter of 4 feet and, when moving up and down in the narrow vertical shafts, exerted a plunger-like effect that materially assisted in the work of ventilation. The contents of the 4-foot buckets were discharged directly on to inclined dump boards, whence the muck was delivered to a spoil heap in the bottom of the general excavation. There a Marion No. 37 steam shovel loaded the muck into trains of side-dump cars.

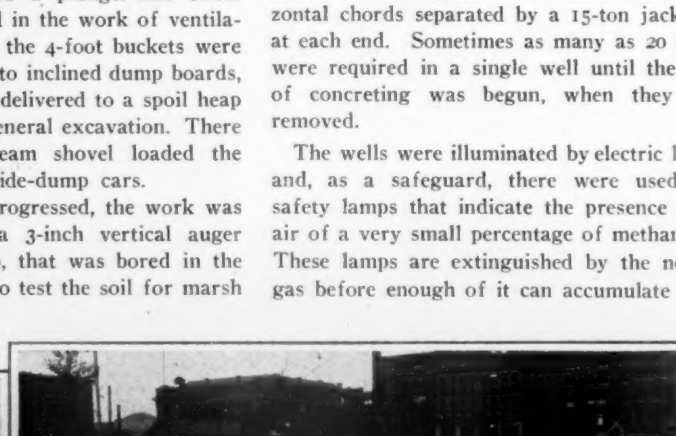
As the excavating progressed, the work was always preceded by a 3-inch vertical auger hole, 5 or 6 feet deep, that was bored in the bottom of each shaft to test the soil for marsh gas. This gas made its presence known by bubbling up through the water with which the hole was kept filled.

Surface water and seepage in the bottom of the general excavation was taken care of by four 3-inch pumps driven by gasoline engines and mounted on trucks that enabled them to be easily shifted from place to place, as desired. Some of the water entering the upper portions of the wells was removed by steam pumps; but most of the seepage was handled by two 3-inch centrifugal pumps which, together with their 10-h.p. electric motors, were mounted in frames and suspended in the wells. As an excavation increased in depth, one of these pumps was progressively lowered until the maximum pressure head was reached. Then it was supplemented by the other pump, which was lowered to within 8 feet of the bottom of the well. The exhaust pipe of this pump was connected to the suction pipe of the overhead pump which, in turn, discharged into an open ditch, about 3,000 feet long, that emptied into the Cuyahoga River. Each pump had a capacity of about 200 gallons per minute at a discharge head of 130 feet. These two pumps sufficed to take care of the water in all the deep wells on the job, and were kept in almost continuous service in handling gritty water—doing the work without any loss of time for repairs, breakdowns, or renewals.

In certain places the plastic clay, after being exposed to the atmosphere, swelled so much as to set up dangerous squeezing of the vertical sheeting staves. Wherever that occurred, the staves were reinforced by short horizontal drums, each consisting of two framed timber segments that had their horizontal chords separated by a 15-ton jackscrew at each end. Sometimes as many as 20 drums were required in a single well until the work of concreting was begun, when they were removed.

The wells were illuminated by electric lamps; and, as a safeguard, there were used four safety lamps that indicate the presence in the air of a very small percentage of methane gas. These lamps are extinguished by the noxious gas before enough of it can accumulate to en-





Two views of the main excavation for the Terminal Tower Building. The positions of some of the foundation wells are indicated by tarpaulin-covered headframes.

In excavating the foundation wells, air-driven I-R clay diggers were found very helpful.

danger human life. Sometimes the gas entered the wells through the sides and was not detected until after the excavation had gone several feet below the elevation of the gas seam. On occasions the flow of gas was so great that the workmen had to withdraw from a pit; and it was necessary to force an extra large supply of fresh air down the shaft in order to properly ventilate it.

The smaller wells, some of which were carried down to a depth of 120 feet, were not excavated to bedrock. However, 16 of the deeper shafts were sunk to rock more than 200 feet below the bottom of the main excavation. The underlying rock was penetrated to a depth of about 10 feet with "Jackhamers."

After the excavating was completed and the bottoms of the shafts had been satisfactorily prepared, the wells were filled with concrete mixed in 1-yard batches at a rate of not less than a minute a mix. The material was delivered by bucket to a 240-foot steel tower, whence it was distributed through long steel chutes to the points of use at a maximum rate of 750 yards daily. This equipment, besides handling 18,000 cubic yards for the foundation piers, was also utilized to place several thousand cubic yards of concrete required for the high and massive retaining walls of the 52-foot excavation.

The excavating of the entire area was finished before the foundation wells were started, and was done with a fleet of steam shovels. One of these—an Erie, with caterpillar traction—was subsequently fitted with a 35-foot derrick boom. Because of its mobility, this shovel proved very useful in handling the steam hammer and in doing service generally as a crane. Immediately after the completion of the foundation, work was begun on the erection of the 17,000 tons of structural steel forming the framework of the great building.

PAPER SHUTTLE CLEARS CABLE DUCTS

BEFORE electric cables are drawn through underground ducts, it is generally the practice to clean those conduits to remove any possible obstructions. Where the line is straight this work offers little difficulty, and is usually done by the rodding method. But ducts cannot always be laid in a straight line. In that case, the cleaning has been known to give trouble.

It should therefore be of interest to learn that the Boston Edison Company has devised and is using a very ingenious but simple means for cleaning conduits that is proving very satisfactory in service. It consists of a stout paper shuttle, of conical form, to which a string is securely attached. The diameter of this shuttle is ¼ inch less than that of the interior of the duct, into one end of which it is placed. When in position, compressed air at a pressure of 15 pounds per square inch is applied to force the shuttle through the conduit, whence it is readily withdrawn by the string.

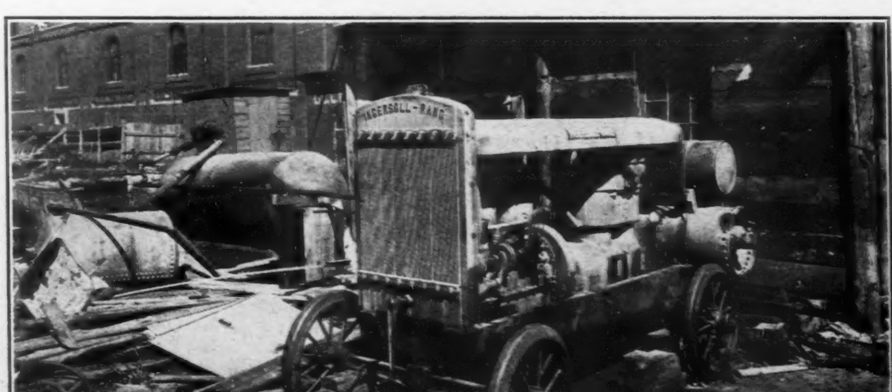
PACKED CEMENT LOOSENED WITH COMPRESSED AIR

LIKE other finely divided bulk material, cement packs in storage and must be loosened before it will flow freely from the bins. As the discharge gate is at the bottom of each bin, the work of breaking up the solidly packed mass—which tends to form a bridge above the gate—has heretofore been both bothersome and slow, and has generally been done by thrusting long rods up through the opening. This method is now being gradually discarded for one that is far simpler and more efficient, and which makes use of compressed air.

We learn from *Pit & Quarry* that the practice is to introduce an air line into the bottom of the bin. After the discharge gate is tightly closed, air at approximately 100 pounds pressure per square inch is forced through the pipe into the mass. In this way, the air that was originally squeezed out of the material by the weight of the upper layers is soon restored, and the cement once more becomes light and fluffy—the condition in which it flows readily.

NEW COPPER LEACHING PROCESS

A NEW leaching process for copper, that promises to do the work in minutes as compared to days, has been developed by W. Hassard of New Westminster, B. C., according to the *Western Canada Mining News*. In making laboratory tests of his process in the plant of the Dominion Ore Concentrating Company, Mr. Hassard was able, so it is claimed, to leach copper out of ore in from 15 to 20 minutes, using for the purpose an ordinary developing pan and ore crushed to a 20-mesh. This is in striking contrast to the older methods now commonly employed that take anywhere from 7 to 9 days to produce copper in solution. Large-scale tests of the process are to the undertaking by the Dominion Ore Concentrating Company.



Air for operating the numerous clay diggers, as well as the paving breakers and "Jackhamers," was supplied by portable compressors of this type.

Portable Compressor Helps Sugar Planter

By M. CHOSE

MAURITIUS, so named by the Dutch in 1598, is a British colony lying in the Indian Ocean 550 miles to the east of Madagascar and about 1,450 miles away from the east coast of Africa. The island has a total area of approximately 710 square miles; and its northernmost tip overlaps the 20th parallel of longitude south of the equator.

Mauritius was once the habitat of the dodo. Its fauna still contains numerous curious forms of animal life, and fossil records exist of others even more curious. Sometime in the dim past, the Island of Mauritius came into being because of volcanic action; and certain of the mountains bear fantastic evidence of the upheaval, in far-off days, of the ocean bed.

Mauritius has been a British possession since 1814; and was one of the fruits of the long war waged between France and England during the early years of the 19th century. Because of its tropical climate and the fertile nature of the island's red-clay soil, the growing of sugar cane has flourished increasingly since the industry was first established there by an enterprising French governor in the beginning of the 18th century. The vivid green of the cane fields adds a touch of picturesqueness to the country. However, the growing of sugar cane has occasioned numerous economic crises—first, owing to the destruction of the crop by not infrequent tropical storms and then to the competition offered by other and more favored sugar growers. Even so, cane sugar is still the principal source of revenue of the island.

Despite the fertility of the soil, the volcanic origin of Mauritius has made the farmer's task a difficult one. So violent must have been Nature's mood when the island came into being—and perhaps for a long while afterwards while what is now called Grand Bassin, a deep lake, was an active volcano—that the surface of the island was covered with volcanic breccia. These stones, of all sizes, are so extensively mingled with the soil that seldom if ever can a plough be used to clear the ground for cultivation; and, as a consequence, this work must be done by hand and largely with the hoe.

Until recently the boulders and lesser stones were simply removed and piled nearby in rows flanking relatively narrow areas in which the cane could be planted. This did well enough until property values rose and there was a monetary urge to make a fuller and more profitable utilization of the lands under cultivation. In this essential work compressed air has recently had its part to play on one of the best managed of the properties—namely, the Bel Ombre Estate.

Barometric condensers, of a well-known American type, installed in a sugar mill on the Argy Sugar Estates in Mauritius.

The management of the Bel Ombre Estate decided last year to make a departure in a long-established practice by breaking up the boulders and clearing them away so that more of the ground could be used for planting cane. The removal of each row of boulders has afforded additional space on which a row of sugar cane could be grown. In the work of drilling popholes in the boulders, "Jackhamers" have been employed; and the operating air for these rock drills has been furnished by a 5x5-inch Type 20 portable compressor. In this way, every acre will be made considerably more productive than has heretofore been the case.

The increased revenue, thus realized, will help to offset the destructive action of the more or less periodic hurricanes. These storms strike Mauritius during the wet season between January and the middle of April, and are usually accompanied by torrential rains and violent winds that last for seven or eight hours—doing great damage to habitations and crops the while.

A portable compressor and "Jackhamers" breaking up boulders in a cane field on the Bel Ombre Estate in Mauritius.

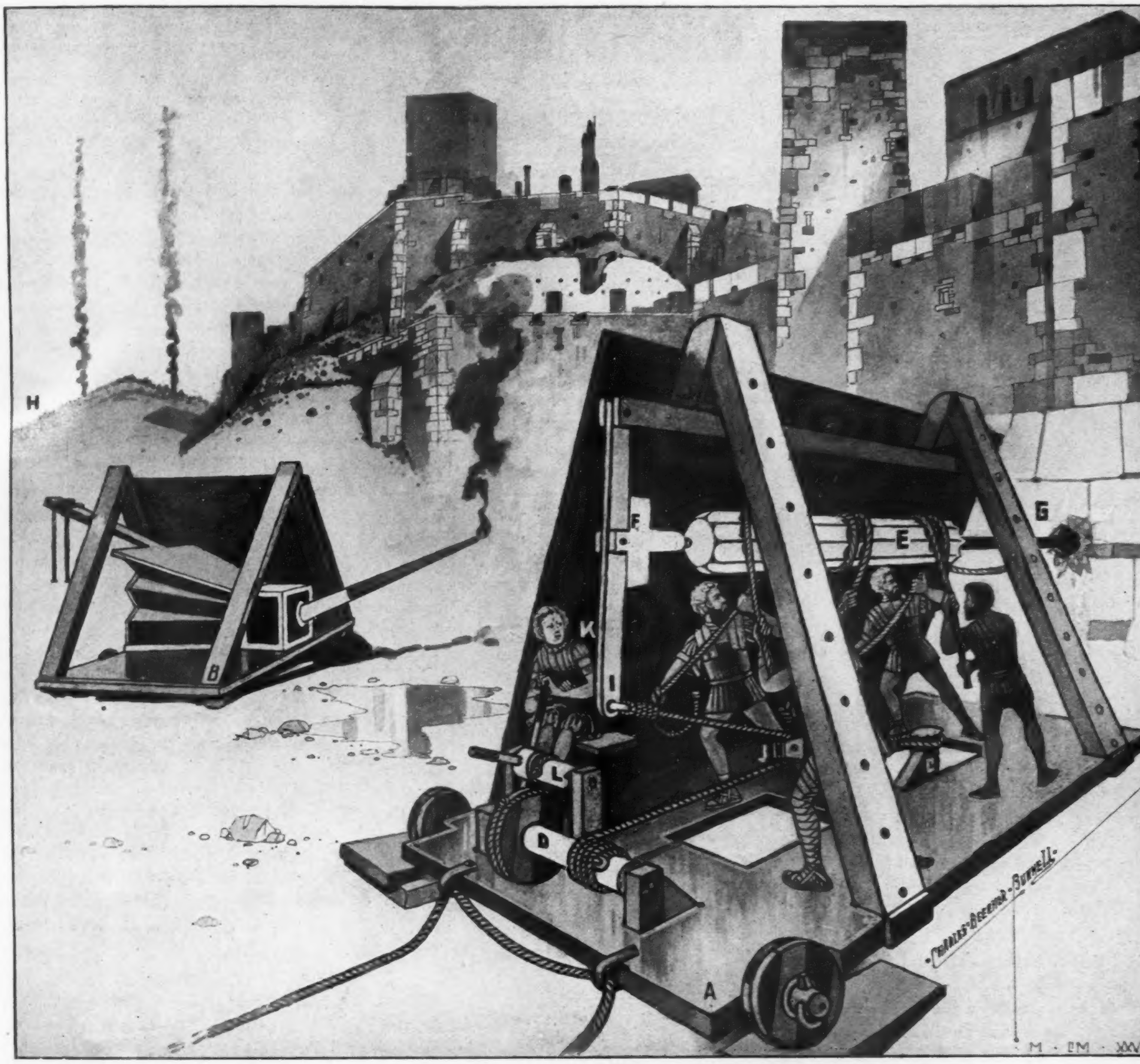
BIG FIND OF BORAX IN CALIFORNIA

GREAT interest has been aroused among those concerned in the borax industry in the discovery near Kramer, Calif., of a huge deposit of this valuable mineral. Exploratory borings have been made; and it has been estimated that within a single claim of 20 acres there are 4,000,000 tons of borax.

According to the *Nevada Mining Press*: "The discovery was made months ago by an engineer who drilled a hole near a seepage of water that was strongly impregnated with borax. At 300 feet the drill brought up pure borate mineral. Later development by drill holes and shafts is said to have proved 4,000,000 tons of borax which is so transparent that a newspaper can be read through it."

The deposit is reported to be the only one known to contain borax in this form, and has therefore attracted attention in scientific circles. It is referred to as a new borate mineral upon which the name "kernite" has been generally bestowed because it was found in Kern County.

The United States Navy's new training 'planes are to be equipped with propellers of canvas—that is, layers of canvas compressed into a material of great strength. This new product is known as micarta—a waterproof substance of steel-like hardness that is built up of sheets of cotton canvas impregnated with certain chemicals. Propellers made of it, when bronze or brass tipped, have proved especially suitable for seaplanes because the material is capable of resisting the corrosive action of water. Micarta is also used for pulleys and fairleads required in airplane construction.



ROCK DRILL OF ANCIENT ORIGIN

WHO invented the first drill for penetrating or perforating rock may never be known. Nevertheless, there are authentic records that ascribe the devising of rock drills to various persons of more or less historic identity and prominence. Among these was Calos, a nephew of Daedalus. Daedalus became jealous of Calos and had him thrown from the Acropolis of Athens. It is not clear whether the invention of that drill or some other reason impelled Daedalus to that murder.

Throughout the far-flung reach of the old Roman Empire, many tunnels were driven; and among those ancient achievements that still occasion wonderment was a tunnel more than 7,200 feet in length driven by military engineers of that period. The drill illustrated by the accompanying drawing was a standard type of military drill used by the Romans both for war and for peace purposes. It is here shown protected with armor so that it could operate before the walls of an enemy's stronghold. One-half of the armor has been removed in order that the essential parts of the drilling equipment can be seen.

The following description has been furnished by the artist. The drill is mounted on an armored car, A; the drill, G, is held by a rotatable chuck, E; and the chuck is pivoted upon a supporting nut, F. Power is applied to the chuck by the alternate pulling, on opposite sides, of three ropes, each of which is passed around the chuck with a single turn. The car is tied to a "deadman" or post, C, projecting through an opening in the car floor. The connecting cable is secured to a block, J, through which another cable is run that is tied at one end to the pivoted vertical lever, I, while the other end is wound around the drum, D, of a windlass. The windlass is operated by a third rope secured to the spindle, L, of a second windlass that is turned by the attendant, K. By winding in on the rope around L, the attendant, K, pulls the car toward the face of the wall attacked and, incidentally, presses the drill against the rock, causing the tool to advance and to penetrate the wall.

The metallic bellows, B—also protected by armor, was designed to force asphyxiating fumes through a completed hole into the living spaces or defensive positions of the foe. For this purpose, sulphur, phosphorus, and asphaltum were employed to produce both smoke and noxious fumes.

For purposes of peace, where the drill crew could be more numerous and the space available for operating ampler, it was possible to develop more power. And this power could be increased many times by utilizing multiplying pulleys instead of a block with a single sheave, as indicated by the accompanying picture.

PLATINUM FROM THE TRANSVAAL

WORD has been received from the American Consul at Capetown that South Africa's new platinum deposits have reached a stage in their development that warrants the prediction that the Transvaal will become one of the world's leading producers of that precious metal. He reports that the most important deposits were consolidated in 1926 and are now in the hands of several of the big mining companies.

Approximately 4,951 ounces of platinum, valued at about $465,000, was produced last year. While this is not a large output, it came entirely from experimental plants—so-called pilot plants, of which there are now four in operation. There is every likelihood that as methods are improved and difficulties of extraction are overcome the output will be measurably increased.

CLEANING ARTESIAN WELLS WITH COMPRESSED AIR

WATER works and industrial plants that depend on Artesian wells for their water supply must resort to periodical testing and cleaning of such wells to keep the flow normal. If the level of the water drops, the cause of this should be determined. Infiltration of sand and dirt through the strainers is a common source of trouble and, if neglected, may even result in a well going dry. To prevent this, wells should be washed out frequently. According to a recent issue of *Power*, this work can be done with compressed air, and the line of procedure is as follows:

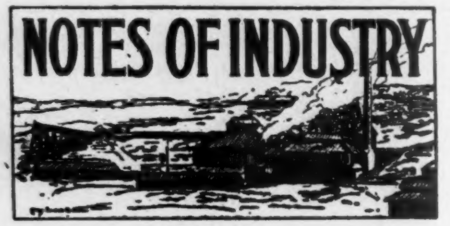
Take off the plug in the tee on top of the well and put a nipple and tee in its place. In the top of this tee put a plug with a hole big enough to allow a ¾-inch pipe to slide through it. The depth of the well should be taken with a tape measure; and enough ¾-inch pipe screwed together to reach within a foot of the bottom of the well. A clamp on the pipe, resting on the plug, will hold it in position. With wells 100 feet or more deep, a 3-legged derrick is a handy rig for lowering the piping.

The top of the pipe should have a valve to control the air; and a flexible connection, such as a rubber hose, should be used to connect it with the main air supply. With this combination, the pipe can be lowered and raised easily. After the air is turned on, the water will flow out of one arm of the tee; and, if necessary, a piece of pipe can be screwed into the tee to carry off the water. By shutting off the air supply for a few moments every 15 minutes or so the water at the bottom of the well can be agitated—thus speeding up the work of freeing the well of the clogging sand.

SPONTANEOUS COMBUSTION OF COAL

AS a result of investigations conducted by the Safety in Mines Research Board, of England, it has been revealed that the main cause for the spontaneous combustion of coal is "the direct action of atmospheric oxygen on the coal, itself." The report published by the Research Board goes on to say: "The assumption that pyrites are mainly responsible for starting the spontaneous combustion of coal has not withstood quantitative tests. Though gradual oxidation of the pyrites helps to disintegrate the coal and facilitates penetration of the air into the lumps, the proportion of the oxidizable sulphides in the coal is in general small, and the heat of their oxidation can hardly raise the temperature of the mass to any significant degree." In other words, while certain classes of pyrites may actually bring about coal fires, the Research Board holds that oxygen rather than pyrites is the main cause of ordinary cases of spontaneous combustion.

At a recent meeting of the Montana Society of Engineers, held in Butte, Morgan H. Wright, of the Ingersoll-Rand Company, was elected one of the trustees.



Gasoline can be extracted from lignite, according to a report read recently by the Chief Mines Engineer of the French Government to the Commission on Mines of the Chamber of Deputies. The report gives two French chemists, Albert Prudhomme and Eugene Houdry, credit for the discovery of a process that makes this possible. The process of distillation has so far not been made known; but it is said that a ton of lignite treated in a small plant has yielded 5 gallons of gasoline, 4 gallons of fuel oil, and a quantity of sulphur.

A total of 1,650,000,000 pounds of candy was consumed in the United States in 1926.

Statistics reveal that the taxicab is crowding out the 'rikisha in Japan. From a total of 39,083 jinrikishas registered there in 1897, the number has dwindled to 3,343.

According to *The Engineer*, Sweden has for some years past been using white water—that is, the waste liquor from her numerous sulphite-paper mills—to lay dust on highways. This water has been found to be more satisfactory for this purpose than ordinary water, as it tends, on drying, to bind the dust and to make the roadway smooth. To still further add to its effectiveness, it has been suggested that a quantity of hygroscopic salt, which absorbs humidity from the air, be added to the white water so as to keep the surface of highways slightly moist.

The Canadian Government has appropriated $5,000,000 for the completion of the Hudson Bay Railway to Hudson Bay. It has not yet been determined whether Fort Churchill or Port Nelson is to be the terminal; but Fort Churchill is being favored by engineers who have recently concluded a four months' survey of the proposed extension of the line.

Cleaning steel extractor boxes—some of which had seen more than 25 years of service in the plant of the Llanglaagte Estate Gold Mine, South Africa—yielded 1,450 ounces of gold. The boxes were scaled; and then, when it was found that the returns justified the effort, they were coated first with salammoniac and next with strong hydrochloric acid. After being permitted to stand in that condition for two weeks they were again scaled. A total of 23 boxes was treated in this manner for about a year.

The 1927 roadbuilding programs of the United States highway commissions call for the construction of 26,841 miles of highways of all kinds.

Export cargoes passing through United States ports in 1926 exceeded 112,900,000 tons —an increase of 20 per cent. over those handled during the preceding year. Lake shipping also set a record in 1926, with a movement of 121,289,502 net tons—8,000,000 tons more than in 1925.

The steel industry of the United States is encouraging a line of research, the ultimate object of which is to make us independent of foreign sources of manganese ores—our own reserves of this mineral being inadequate to supply the demand. It has been found that the slag from open-hearth furnaces contains as much as 8 per cent. manganese, and efforts are now being made to recover it for re-use.

Metallurgists and the mining world generally are keenly interested in the recent discovery of large deposits of lode tin in Currie County, Oregon. Samples of the ore from one of the properties, tested and analyzed at the Minnesota School of Mines, have indicated values up to several hundred dollars per ton.

That the United States has undergone a marked acceleration in productivity in relation to population has been strikingly brought out by the following figures compiled by the Harvard Economic Service. From 1900 to 1927, the population has grown 56 per cent. In contrast, the physical volume of manufactures increased 190 per cent. from 1899 to 1925, while the output of the mining industry within the same period increased 125 per cent.

On January 1, 1927, there were in the United States 465 petroleum refineries with a total daily capacity of 3,061,007 barrels of crude oil.

To reduce the breakage of automobile windshields and, incidentally, to prevent injury to the front-seat occupants, an attempt is being made in Great Britain to find a material suitable for this purpose that does not shatter as easily as glass. To this end, experiments are being made there with "pollopas," which is already used to glaze portholes. Pollopas is a product of urea and formaldehyde; and is a transparent, colorless solid resembling rock crystal or flint glass. The material is said to be highly resistant to shock.

As a step towards conservation, Germany is planning to build a vast pipe-line system that is to supply consumers living far and wide with by-product gas from her numerous coke plants. These plants produce annually 495,000,000,000 cubic feet of gas, as compared with the 105,000,000 cubic feet manufactured yearly by her regular gas plants. This pipe-line service is to have a total length of 1,700 miles.

Sand-blasted redwood for interior decorating has struck the popular fancy in California, the home of the *sequoia*. Entire walls are being panelled with redwood, the beauty of which is greatly enhanced, so it is said, by the sandblast treatment.

Compressed Air Magazine

—Founded 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

Business and Editorial Offices:

Bowling Green Building, No. 11, Broadway, New York City. Tel. Bowling Green, 8430

Publication Office: Somerville, New Jersey

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries $3.50 a year, postage prepaid. Single copies, 35 cents. Back issues more than six months old, 75 cents each.

EDITORIALS

COMPRESSOR INCREASES OIL-WELL OUTPUT

IN the course of less than a year, the Seminole district in Oklahoma has produced in the neighborhood of 45,000,000 barrels of petroleum! This record stands unsurpassed even by the famous Cushing field in its palmiest days.

What has been achieved in the Seminole field is the present climax of engineering efforts in which the compressor has played a conspicuous part. The compressor, used either to compress air or gas, has been employed for substantially a quarter of a century and with varying degrees of success to bring about a greater ultimate recovery of oil by restoring or supplementing natural forces. Latterly, the results have been strikingly successful; and the Seminole field offers the most spectacular evidence of this use of the compressor.

As everyone at all familiar with the recovery of petroleum knows, the oil reaches the bottom of the well and thence rises to the surface generally because of the force exerted upon it by superposed natural gas or by the expansion and liberation of the gas held in solution in the oil. When the pressure of the natural gas drops so that it no longer is able to impel the petroleum either to the surface or to the well—from which it can be withdrawn by pumping, bailing or swabbing—then, ordinarily, no more oil can be recovered. But if the discharge of natural gas can be checked, and the work of raising the oil to the surface can be helped out by compressed gas or air sent down from the surface, then the gas in the ground—either above the oil or dissolved in it—will continue longer to move the oil from the sand to the well and, perhaps, extend the flowing period of the well for weeks and months more than would be the case if the natural gas were permitted to exhaust itself by an unregulated discharge.

The adaptation of the air lift to oil wells, using either compressed air or compressed gas to aid Nature, has made it possible not only to speed up the output of a well but to greatly augment the ultimate total volume of recovered petroleum. Furthermore, the compressor employed in this fashion has made it commercially practicable to withdraw oil at a profitable cost when the oil could not be brought to the surface at a reasonable cost by any other method.

This application of the compressor to induce a prolonged flowing period is the opposite of that use of the compressor which has for its purpose the direct substitution of compressed air for the pressure of the exhausted natural gas—that is, air instead of gas is applied to the sand so that it will force the residual oil toward one or more wells from which it may be recovered. The significant and outstanding meaning of these developments in petroleum engineering is that it will henceforth be feasible to recover greater quantities of oil than has commonly been possible heretofore; and, furthermore, wells that are too deep for pumping or swabbing may still be made to yield their fluid riches with the help of the compressor. Manifestly, these accomplishments have postponed the day of exhaustion even though they may temporarily promote an overproduction of oil.

HYDRO-ELECTRIC PLANTS OF A NOVEL SORT

A FULLER utilization of water-power resources and a wider distribution of energy developed by hydro-electric plants were discussed in a document issued a few weeks ago by the League of Nations in connection with the International Economic Conference.

Therein, attention is called to the practicability of rearing dams at high levels to form reservoirs into which water could be pumped by otherwise unemployed energy generated by power plants not at the moment working to capacity to meet load conditions. The purpose of thus using idle power resources would be to pump water to points where the accumulated water could be drawn upon at peak-load periods to generate energy that ordinarily is produced by reserve generating units that are called into service only intermittently and which represent large investments.

It is a well-known fact that power plants when working continuously at capacity can produce energy at a much lower cost than is the case when the plants are operated at capacity only for a few hours out of every twenty-four. The object of using idle power to pump water to high reservoirs would be to create pools of potential energy, so to speak, that could be transformed into electric current for continuous distribution far and near to points requiring additional current when local demands at the pumping stations did not necessitate operating them to capacity. The idea is an ingenious one; and under some conditions it might be developed to advantage in a practical way.

BANKERS ANALYZE VALUE OF MOTOR TRUCKS

THE influence of motor vehicles upon the railways of the nation was recently discussed in a report prepared by the Commerce & Marine Commission of the Executive Council of the American Bankers Association. The report contains many illuminating figures. Let us quote:

"The motor-vehicle industry now ranks first in our national industries. The capital invested in motor vehicles and in highways improved primarily for motor-vehicle use is in excess of the total invested in railroads. Automotive and allied industries have on their pay rolls about 8 per cent. of all persons gainfully employed in the United States. In repair shops, public garages, professional chauffeurs and truck drivers, the total is greater than for railroad workers of all classes."

The annual tonnage loss by railroads to motor trucks, although estimated at 8,000,000,000 ton-miles, was only about 2.1 per cent. of that handled by the railroads; and the loss to the trunk lines was more than equalled by the large volume of automotive freight carried by the railroads. Continuing, the report states:

"The motor truck meets a real public need in providing quick, flexible service for distances from 30 to 60 miles. It is in the interest of the railroads as well as that of the public to acquiesce in the diversion of that traffic to the highways so that railroad facilities may more profitably be used for long-haul traffic. That traffic is growing in volume; and the gain is much greater than the loss of local less-than-carload freight to trucks."

Assuming the foregoing statements to be accurate, the value of improved highways grows directly with increase of use; and, conversely, the wisdom of building these roads well in the first place and of properly maintaining them is emphasized proportionately.

FRANCE TO BUILD RAILROAD ACROSS SAHARA

MOTOR-DRIVEN vehicles have robbed the Sahara Desert of some of its obstacles to transportation. In short, these mechanical means of carriage have established the practicability of a trans-Saharan railway. Accordingly, the French Chamber of Deputies has recently authorized an appropriation of 18,000,000 francs to cover the expense of an engineering survey and the preparation of finished plans for the building of a railway across the great desert. This step brings to a present climax a project that has been urged with virtually equal intensity by the military and the commercial authorities of France for the better part of a decade. A glance at a map of North and Central Africa will make plain why a trans-Saharan railroad has been so per-

sistently advocated by persons deeply concerned with the national defense as well as with the economic welfare of France.

Within her African possessions, France has a population of 40,000,000 people; and a great part of these people would undoubtedly lend themselves to profitable productive efforts if they could be brought closer by rail with France. The enormous natural riches of the French possessions in Africa are to a large extent unexploited because of the isolated positions of some of the richest of these territories. It is the intervening Desert of Sahara that is mainly responsible for this isolation.

A railroad built across the Desert of Sahara and linking French Central Africa with a French African port on the Mediterranean would bring about an economic and an industrial transformation—at the same time uniting France with this vast storehouse of potential wealth and man power.

The construction of a railroad across the desert would, of course, bristle with difficulties, and there would always be the problem of neutralizing the effects of frequent and often severe sandstorms. Furthermore, the use of steam locomotives would necessitate the creation of coaling and watering stations along the route—problems of considerable moment. However, this phase of the project might be made easier of solution if the engineering experts decided to employ oil-electric locomotives which do not need coal and which use so little water that the locomotives could carry sufficient of it to tide them over the longest of probable runs.

The world at large will await with interest the results of the authorized survey and the determination of the route that will be agreed upon for the trans-Saharan railway. The building of the road will call for the utilization of modern labor-saving machinery of many sorts.

NEW MEANS OF MATCHING COLORED MATERIALS

MATCHING colors has been a problem for hundreds of years; and it is recorded that the human eye may become so acute that it can distinguish nearly 150 different shades of red. This acuteness, however, is limited to relatively few persons; and industry in its many departments of activity must rely upon more positive aids in the form of colorimeters of one sort or another.

The working essentials of many of these apparatus are a powerful artificial light and a suitable reflecting medium which projects the color of the substance under test upon the vivid white surface of a piece of magnesium carbonate—the carbonate serving as a standard of comparison. The eye, however, is the final arbiter. Recently, there has been perfected by members of the staff of the Massachusetts Institute of Technology a colorimeter that goes a step further. This instrument analyzes the wave length of the color under examination and automatically registers the identity of the hue and the shade; and this record permits the reproduction of the exact color by reversing, so to speak, the application of the apparatus.

It should be self-evident that an instrument of this sort will prove of much value both to industry and to the laboratory at large. One can even imagine its wider application in determining the real value of the fleeting blush or the significance of red in the "old man's eye" when his wrath may range all the way from pink to crimson.

BUSINESS CORRESPONDENCE HANDBOOK, edited by James H. Picken, M.A. A volume of 836 pages, published by A. W. Shaw Company, Chicago and New York. Price, $7.50.

THE purpose of this work is, of course, to help towards a general and much-needed betterment in the letters and reports commonly written by business concerns. The author tells us: "This volume is a discussion of business correspondence from the two points of view. On the one hand, the effort is to give a true picture of the various ways in which business letters are used by modern business organizations. On the other hand, an attempt is made to set up rules or standards of practice by which those who do business by mail should proceed in order to realize the best results." Manifestly, the book is sizable and the treatment comprehensive. In this way, the volume stands apart from most other books of a kindred character; and it should be of great aid to many persons interested in this important subject.

THE CONQUEST OF DISEASE, by Thurman B. Rice, A.M., M.D. Assistant Professor of Sanitary Science, Indiana University School of Medicine. An illustrated book of 363 pages, published by The Macmillan Company, New York City. Price, $4.50.

THIS book is heartening not only because of the message it carries but because the author deliberately sets out to enlighten the general public. We can all recall how frequently the medical fraternity has doubted the capacity of the laity to understand things that, in the last analysis, mostly concern the populace. Doctor Rice has gone to some pains to deal with his various topics so that the average person will be both interested and informed the while. He says: "It is my firm conviction that the complete conquest of the transmissible diseases waits as much upon the intelligent appreciation of the facts by the laity as it does upon the advances in research made by the medical profession." Doctor Rice has written lucidly and entertainingly, and he has treated each of his topics in a way that should prove well worth the reading by any and all of us that seek guidance in such vital matters or by those of us that are called upon at times to influence or to guide others.

SEEING THE SOUTH SEA ISLANDS, by William Lee Calnon. An illustrated work of 224 pages, published by Frederick H. Hitchcock, The Grafton Press, New York City. Price, $3.00.

FEW there are of us that have not read of the South Sea Islands and the habits of life that prevail there—habits that seem far more alluring, not to mention more pleasurable, than the relatively conventional practices that hamper us at times in the populous midst of civilization. Some of the books—probably most of them—that have treated of life in those tropical regions have been fanciful in so far as they did not always stick to the facts. The author of the present volume is no less responsive to the existing charms, but his desire has been to please and not to mislead by allowing his imagination to run riot in the telling of his story. As he expresses it: "There is a widespread interest in the romance and beauty of the South Seas' myriad isles, but because of the admixture of fact and fancy that has been written about them many misconceptions exist in the public mind concerning them. It is hoped that this work will be of some service to those who plan some day to visit the South Seas themselves; also to those who have not this privilege, but wish to know the truth about them."

SECRETS OF THE FRIENDLY WOODS, by Rex Brasher. A work of 220 pages handsomely illustrated with original drawings by the author. Published by The Century Company, New York City. Price $2.50.

MOST of us pass through woods with our objective mainly occupying our minds, and we give but casual heed to the surrounding timber and its teeming animal life. For all the pleasure we get out of it, we might more often than otherwise be led through the forest with our eyes blindfolded. This is not because of a lack of living things to interest us but only because our usual environment is that of the town or city with principally houses and human beings to engage our attention.

The author has opened the way to a fuller and a pleasurable understanding of what is to be found in the woods. He has given the denizens of the forest an individuality that is both colorful and charming, and he has brought out the inter-relations of these varied creatures with God's great scheme of animate existence. While told in a narrative form and as incidents in his own pursuits, Mr. Brasher has succeeded in imparting much useful and valuable information, and he has, at the same time, made his story a fascinating one. His book will open your eyes and greatly add to the enjoyment of a day in the woodland.

The Demolition & Construction Company, Ltd., 72 Victoria Street, London, England, has recently issued an illustrated pamphlet dealing with various fields of service in which that concern has operated in clearing away old foundations and other obstructions standing in the way of new work or necessary structural expansions. This brochure should prove of interest to persons and firms having jobs of a like nature in prospect.

II

am
res,
af-

of
life
al-
nan
am-
ivi-
nost
ose
r as
The
on-
has
ring
his
ide-
of
the
peen
xist
ped
nose
Seas
this
bout

Rex
nely
hor.
York

our
inds,
und-
r all
nore
orest
ause
but
t of
and

uller
is to
the
that
has
aried
mate
n and
asher
and
same
His
ld to
l.

pany,
l, has
ealing
con-
foun-
n the
l ex-
of in-
of a